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|  | | Computer Science Concepts | | | | |  | |
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# Introduction

## Spotify

In this document, I will be discussing 6 Computer Science Concepts relative to Spotify, an audio streaming service that dominates the audio streaming Industry. It is primarily known for their music streaming service that allows you to listen using the web or one of its applications, however, podcasts are also a big hit on Spotify.

Audio streaming is a good software to explore as it is something, we are all familiar with, Spotify, in particular, is interesting as they set the industry standard. This piece of software will allow us to discuss a range of computer science concepts as it uses many aspects of a computer such as the CPU and RAM to run the software & the web to access and receive the packets of data to stream the music.

## What is Software?

Software is a set of instructions that tell computers what to do, without software computers would be useless as the software is needed to accomplish the input, processing, output, storage, and generally control activities of computers. There are four main types of software, these are system software, application software, programming software & driver software.

### **System Software**

System software helps the user, hardware, and application software to interact and function together. System software is designed to provide a platform for other software. An example would be an operating system like macOS.

### **Application Software**

Application software is defined as any program designed for end-users. These types of software are productive programs that help you perform tasks. It is a broad term, but an example could be MS Excel.

### **Programming Software**

Programming software is programs that are used to write, develop, test, and debug other software. They are mainly only used by developers and an example would be Notepad++.

### **Driver Software**

Driver software translates commands of an Operating System for the Hardware or devices, assigning duties. Usually, the operating system comes built-in with drivers for mouse, keyboard, and printers by default. An example would be a Printer Driver.

# Abstraction

Abstraction is a simplified representation or way of thinking about a piece of software that emphasises the key details and abstraction is essential to understanding how computers work. The main goal of abstraction is to remove the unnecessary complexity so that we as humans can understand a process a computer performs. The most basic abstraction is to represent things as numbers (almost any data can be represented this way), in contrast to a complex abstraction which would be our most basic understanding of what a compute is doing without considering the complexity.

## Using Abstraction To Understand Spotify

Music streaming is a complex infrastructure of hardware, software, networks, encoders, decoders, and other devices. Whenever an audio file is streamed, first it is converted into small chunks of several data packets using encoders which is then pushed to the network for transfer through the internet. Once the packets are received by your PC, the data is buffered on your computer and played pretty much straight away. The player opens the packets and lays the data out on a timeline on the player. The Play Head identifies the position of the song being streamed. This would be a good abstraction of the process as it is complex enough so that you can understand what's happening at each step of the process with some detail but it's not an overwhelming amount of information to understand.

# States

State commonly refers to the present condition of a system or entity, it is usually understood as a set of values in coordination with variables running a system at that exact moment. There are examples of 'state' all around for example a computer can be on or off. The state of a computer program would be the values of all variables in memory, the registers in the computer, among many other variables in the computer. These states are usually understood by the computer in binary which is a base 2 number system meaning there are only two digits, 1 and 0, which correspond to the on and off states the computer can understand.

## Changes of State in Spotify

Spotify has many states, these states can be changed by not only internal factors (computer) but also external factors (such as poor bandwidth & the user). The user can change the state of Spotify by pausing and playing the audio file on the player, the two states the player can be in is paused or playing. The user can also queue a song to play next which will play once the current song has finished also, the music can buffer if the Wi-Fi is too slow. If the device does not have enough RAM to run in the background, then the song may begin to buffer and pause the song.

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# Modularity

Modularity is about creating systems that are made up of simple modules that interact with one another & can be referred to when discussing both hardware and software. Modularity is essential for developing code and understanding code as it allows software developers to break down code into elements and work on them separately to create a piece of software or application. Developers make use of existing elements from the Operating System, Open-Source Software or other Developers Code instead of having to rewrite the software and ensuring their code is compatible on a plethora of devices. An example of Modularity would be Driver Software as it must interact with the OS and a piece of hardware, therefore, it has two modules attached to it

## Modularity of Spotify

When Developing the code for Spotify, the coders would have had to consider several areas to code, so they would have split up the code to make the task more manageable. They may have decided to split the code into modules like the following:

* The User - Spotify Developers would have had to write code specific to the user, such as creating a database for their users & making the site/application as simple to use as possible.
* The Music Player - The Development Team would have split this into a module to efficiently design and build a unique and effective music player
* The Music Library - The Music Library would have been split into many modules as there would have been many aspects of code to make the music library perform all its functions

These modules may have been divided further as the code would have been very complex and would have been passed among a team of developers. This shows the importance of modularity in computer science as its an effective way to manage and develop complex code.

# CPU & Memory

The Central Processing Unit (CPU) is the chip that gives the system instructions and does all the calculations of a computer, specifically the arithmetic logic unit (ALU) does the calculations. The CPU takes input from the computer's RAM, decodes and processes the instructions, before returning an output. Memory, also known as the Random-Access Memory (RAM) stores the information your computer is actively using so that it can be accessed quickly. The CPU chip retrieves data from the RAM. The chip takes those instructions and begins to move and process data through the motherboard in the correct order to its next designated location.

## How Spotify uses CPU & Memory

If the song is downloaded/saved, then it is loaded from the hard disc into memory and at regular intervals, some of the data will be read from memory (most likely the Direct Memory Access) by the CPU. After that, the direct Memory Access (DMA) allows the audio data to be copied from memory to the sound card without going through the CPU which frees up the CPU for other things.

If the song is being streamed then the performance is mainly down to the Bandwidth, however, RAM can mitigate poor WI-FI as RAM affects the storage available for buffering.

# Applications

An application is a computer program, or cluster of programs, that are designed for an end-user, conversely, system software consists of programs that run in the background, enabling applications to run. The application data contains data created by programs. These application data files are normally called resource files. Desktop apps (Application Software) are computer programs and do not need an internet connection in order to be used, they are downloaded to your computer. Some examples of Application Software would be Internet browsers (Chrome & Safari). A web application does not require any installation and runs on your web browser, it requires a constant internet connection to run. Some examples of a web application would be Facebook & Gmail.

## Spotify's Applications

Spotify has both types of application, each offers unique advantages and disadvantages. Spotify's web application does not require any installation to use meaning it can be used on any system with access to the web and does not take up any room on the system's storage. The web application also does not display advertisements on the interface whereas the desktop application does display advertisement on the interface which users may find frustrating. The desktop application does not require any WI-FI meaning it can be accessed anywhere, also it is more secure as you do not have to go outside your LAN to use the software which reduces the risk of 'Sniffing' or 'Spoofing'.

# Machine Learning

Machine Learning is a field of technology that allows machines to learn from data to self-improve. Machine learning is not new; however, it has only become useful and relevant recently because in the past there was not sufficient data like there is now, computers are far more powerful & there are better machine learning algorithms now. Machine learning is in use all around us today as it is used to display relevant adverts and detect fraud on bank cards. Netflix uses an algorithm called 'Nearest Neighbor', which uses a thumbs up system to find out what movie should be recommended to you based on what other people have liked and watched similarly to you. This algorithm is known as supervised learning, as it trains the machine learning algorithm by giving examples based on the users.

## Machine Learning in Spotify

Spotify uses a Machine Learning algorithm to recommend songs, albums, artists & podcasts the user might like, it does this through the 'Nearest Neighbor' algorithm as users can give categories a thumbs up and thumbs down. The algorithm then uses this data to find matches and then displays songs that match the algorithm's data.

# How different technical choices or situations would affect the system?

There are elements outside the computer that can affect the system itself such as poor WI-FI/Network Outages. The computer would be limited to only being able to use local software that does not require Wi-Fi. This would prevent the computer from communicating outside of its LAN; therefore, the computer would not be able to use the Spotify web application & elements of the Spotify desktop application.

Spotify could release an update to Spotify's Desktop Application which could contain very large files. This could make the application run slow depending on the hardware and could also be inconvenient for the user as they may not have sufficient storage.

If the user has multiple applications running at once, the applications will run slow and the entire system will run slow, however, this is dependent on the hardware of the system, particularly their RAM. The more RAM they have, the less likely this will affect the PC.

# References

* https://goldsmiths.cloud.panopto.eu/Panopto/Pages/Sessions/List.aspx
* <https://www.spotify.com/uk/>
* <https://www.howtogeek.com/>