Week 1

Abstraction: Abstraction is the process used to break complex ideas or structures down into simpler forms that are easier for humans to understand, or easier for computers to process.

Abstraction in Data Representation: Complext forms of data are often broken down into simpler components in order to encode them in a numeric form and process them. Eg: A document might be broken down into a string of characters with some metadata.

Notional Machines: Notional machines are an abstraction of real computers which simplify their internal processes so humans may understand their operation. Eg: the turing machine

CPU: The CPU is a component of a computer that executes a program. It reads instructions from memory, and uses those instructions to manipulate data in memory.

Memory: Memory is a broad term used to describe several components of a computer which temporarily store data and instructions while they are being used. Memory is normally volitile, which is to say it only stores information while the computer is in use. It is distinct from "storage" which is used to hold data between sessions, or retain information for programs not currently in use.

Week 2

State: An abstract concept used to describe how a machine (or program) has a number of distinct configurations. Eg: A video player might have a paused or play state. A strange state is a configuration not intended by the programmer, it can often be resolved by restarting the machine or program.

Files: Files are digital containers of information. They will typically contain data as well as metadata, which is information about the data and the file itself. When a file is being used by a program it will often be locked by the operating system to prevent another program from editing it at the same time. Some operating systems also have an "executible bit" attached to a file, which tells the OS whether the contents of the file may be executed as an instruction or not.

Modularity: Modularity is a design approach which separates a system into distinct chunks called modules. Each module has a detailed specification and may be implemented separately from ther others, by another person, another team or even another organisation.

Driver: A piece of software used to control a hardware device. It presents a generic interface to other pieces of software which can interact with it like any other piece of hardware of a similar type. Eg: Libreoffice writer can use a driver for an epson 3200 just the same as a Brother 500.

Applications: An application is a program intended to be interacted with by the end user. They are comprised of code libraries and resource files.

Utility: A utility is an application developed by the OS developer and bundled with the OS.

Week 3

Networking

Networks: A system connecting multiple machines together and allowing them to communicate. Might be a physical connection (eg. Copper cable or fiber optic) or a wireless connection (eg. Bluetooth or infrared).

The Internet: A global network of networks.

Internet Backbone: A top level link between ISPs, usually running between countries.

URL: A human readable network address indicating the location of a resource (file)

IP Address: A machine readable network address indicating the location of a particular machine

DNS: Domain Name Service. An organisation linking human readable domain names to IP addresses.

Security

Malware: General term for software that is intended to cause harm

Virus: A piece of malware which propagates by inserting it's code into another piece of software. This software is then used to spread the virus between systems.

Worm: Similar to a virus except that the malware is standalone software and does not require any other software to propagate.

Trojan: A piece of malware which is copied between systems by users, by presenting itself as non-malware

Spyware: Malware which is intended to extract information from the user without their knowledge

Ransomware: Malware which seizes control of a system, only releasing control when payment is made by the user.

Encryption: A system of rendering a message unreadable to messengers, which then may be rendered readable again by the intended recipient.

Firewall: A system which examines incoming and outgoing traffic from a system and limits them according to predetermined security rules. Firewalls may govern interactions between networks (network firewalls) or individual machines (host-based firewalls).

Week 4

The Internet

Web page: A mixture of document and software which presents information via a browser

Website: A collection of related web pages, typically developed by a single organisation and located at a single domain.

The world wide web: The superset of all websites available via the internet. Specifically everything using HTTP and derivatives.

Protocol: A prearranged system for communicating information

Cookie: A small file stored by a website on an end user's computer to track their usage.

Client: The machine used by an end user

Server: A central machine which provides data and services to clients

Database: A piece of software which manages a structured array of data.

Embedding: The process of including assets from other web pages in another web page. Eg.: An advertisement banner or a youtube video

API: Application programming interface. An interface intended for use by software. Often used by websites to allow third party sites to access their data. Eg: A twitter search engine

Week 5

Data

Bit: A single binary digit, has two states (0 and 1). Can be used to represent all kinds of different information.

Byte: 8 bits. A standard unit of memory since the 1980s. Most programs will not interact with memory in units smaller than a byte.

Word: A unit of memory specific to a particular architecture. Some systems use 8 bit words, others use 16, 32 or 64 bit words. The longer a word, the more precision the system is capable of and the greater it's paralellism.

ASCII: American Standard Code for Information Interchange. An alphabetic encoding system, originally for telex machines. ASCII codes use 7 binary bits, so the remaining bit in each byte was used for different purposes depending on the system. Eg: Storing highlighting information

Unicode: Unicode is a successor to ASCII and provides support for a much wider range of alphabets, ideographics and other symbols. It does not have a fixed code length and any one glyph may be encoded using between 1 and 4 bytes.

Week 6

Compression

Compression: A system by which less bits may be used to represent the same information. With more or less loss of detail.

Dictionary encoding: The use of an index to represent patterns in a file using shorter symbols.

Adaptive Dictionary Encoding: Begins by recognising basic blocks the file is composed of, but then recognises larger superblocks comprised of simpler blocks. Eg: LZW encoding

Run length encoding: Describing a pattern in terms of how long it runs for, rather than recording it's entire length.

Frequency dependent encoding: An encoding system that takes into account how often a pattern occurs, and assigning a longer or shorter symbol to represent it. Also known as Huffman codes.

Relative encoding: Encoding a data stream as distinct data units. Only changes between data units are recorded. Most useful with files which can be broken down into highly repetitive chunks, such as frames from a cartoon. Also known as differential encoding.

GIF: A type of dictionary encoding intended for use with images. Begins by comparing each pixel to a fixed size pallette, then picking the closest match. LZW encoding is then employed to detect patterns.

JPEG: Another image compression format. Takes advantage of the human eye's lower number of cone cells (colour recognition) compared to rod cells (brightness recognition). Initially the image is reencoded in terms of luminence (brightness) and chrominence (colour). The chrominence values are then averaged over 2x2 pixel blocks, allowing the filesize to be substantially reduced without a significant loss in perceived quality. The resulting image is then further compressed and changes beyond those easily detected by the human eye are reduced to zero.

TIFF: Another image filetype. Includes compression techniques similar to GIF and has metadata storage.

PNG: A non patented and improved version of GIF. Intended for transferring images via networks. Consists of a header, identifying the filetype for various systems, followed by a series of "chunks," each of which contains data or metadata. Chunks may be critical (must be decoded) or ancillary (may be decoded).

MPEG-4: A type of file format intended to store video. It is a "container format," which means that a single .mp4 file can contain multiple subfiles, such as video tracks, audio tracks, subtitles, metadata etc.

MKV: Matroska, a video container format intended as an open source alternative to MPEG-4 or AVI.

MP3: A lossy audio compression format which prioritises detail for frequencies human ears are most sensitive to.

Week 7

Computer Architecture

Bus: A common pathway used by multiple components to transmit information. May be serial (information is sent as pulses along a single pathway, possibly being muxed/demuxed at either end) or parallel (information is sent side by side using several pathways).

Register: A single memory cell housed on the CPU itself (or possibly another piece of hardward). Typically stores a single word, on some architectures registers may be paired to store two words. Registers may be general use (used for storing data during calculations) or special purpose (typically used to control hardware, such as jump vectors or memory pointers).

Arithmetic Logic Unit: The component in a CPU which carries out arithmetic instructions, taking inputs from one or more registers, and using it to create an output, to be stored in a register or memory.

Control Unit: The part of the CPU that receives, orders and interprets instruction. Directing data flow and activating processing circuitry as appropriate. Internal components may include: Instruction decoder, Program counter, Instruction register.

Program Counter: The part of the control Unit that tracks which instruction is currently being executed. It contains a register called the instruction pointer, which contains the address of the current instruction, and the instruction register which contains the instruction itself. Typically once a CPU cycle is complete it will increment the instruction pointer, moving to the next instruction. It is also capable of "branching" by jumping to a completely different instruction if particular conditions are met.

Clock: Typically a quartz oscillator. A component which provides electronic pulses to the system telling it how long to spend on any one task.

Motherboard: A circuitboard providing connectivity and glue logic for most of a computer's main components.

Cache Memory: High speed ram stored on the CPU die itself. Also called "L1 (level 1) Cache."

Machine Language: The set of instructions a CPU is capable of interpreting. The lowest form of code, being run directly by the hardware with no interpreter or compiler being involved. Typically machine language would be created using a "machine language monitor." Pure machine language is rarely written directly by humans and is more commonly written in a more human readable form before being translated into machine code by an assembler.

RISC: Reduced instruction set computer. A design philosophy intended to keep machines fast by keeping them simple, and implementing a basic set of instructions which can be combined to form more complex operations. In practice there is no clear

definition of how reduced an instruction set must be to qualify, and many modern RISC architectures are highly complex/bloated.

CISC: Complex instruction set computer. The opposite design philosophy which aims to provide a comprehensive instruction set to the programmer.

MISC: Minimal instruction set computer. Aims to be even simpler than RISC. In practice these are often hobby machines intended to push the limits of turing completeness.

Machine Language

OP-Code: The part of an instruction that indicates the type of instruction to be carried out.

Operand: The part of the instruction indicating what the subject(s) of the operation are to be. Eg, a memory address or a register.

Machine cycle: The process of fetching instructions interpreting them, and executing them.

Illustrative Machine Language

Generic instruction names (from the textbook) are in black. Instruction names from the excercise are in red. These may come up on the exam!

LOAD (MEMLOAD): Retrieve a value from memory and write it to a register
STORE (MEMSTORE): Write a value from a register to memory
WRITE (VALLOAD): Writes a value directly to a register
? (STORE): ?
JUMP (JUMP): Switch the instruction pointer to a new location in memory, branches the program.
STOP: Halts the program

Coffman (1971) identified **four (4) conditions** that must hold simultaneously for there to be a deadlock.

1. Mutual Exclusion Condition
The resources involved are non-shareable.

2. Hold and Wait Condition
Requesting process hold already, resources while waiting for requested resources.

3. No-Preemptive Condition
Resources already allocated to a process cannot be preempted.

4. Circular Wait Condition
The processes in the system form a circular list or chain where each process in the list is waiting for a resource held by the next process in the list.

Mass storage:
Track: An individual circle of bits on a hard disk
Sector: A chord of a track
Zone: Tracks are organised into zones, each of which have the same number of sectors. Zones towards the edge of a disk have more sectors, zones towards the center have less.

OSI: Open Systems Interconnection model

- **Physical layer:** Governs all the actual circuitry and cable as well as standards for bitrate. Includes switches and repeaters
- **Link Layer:** Protocols for exchanging packets between networks, WiFi, Ethernet etc.
- Network Layer: IP
- **Transport Layer:** TCP, UDP etc.
- **Session layer:** Manages the sessions of individual machines on the network, joining, terminating etc.
- **Presentation Layer:** Abstracted interface of an application for interacting with other applications
- **Application Layer:** The meat interface that lets you actually interact with the network