Digital Media

Conor Keighrey

Office: U214

Email: ckeighrey@ait.ie

Lecture Content

- Digitization
  - Sampling
  - Quantization
- Compression
  - Lossless
  - Lossy
- Media Representation

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Binary

- Bits are units of data that can only have one of two values.
- A byte is eight bits.

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Data Representation - Bits

- A bit is the smallest unit of memory
- Bit = binary digit
- A bit is a switch inside the computer, the setting (or value) of each switch is either ON (=1) or OFF (=0)

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Data Representation - Bits

- All data in a computer is represented by bit patterns which are sequences of 0's and 1's
- All numbers can be represented 0 and 1' in base 2
- Hence the term binary computer

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Data Representation - Bytes

- A byte is a sequence of 8 bits
- There are 2^8 =256 possible values that can be represented by a byte.
- Values range from 0 to 2^8 –1 = 255
- Where 0 = 00000000 and 255 = 11111111

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Data Storage: Storing numbers

- Numbers are stored as binary format
- But not all numbers are values between 0 and 255
- Some have decimal points, some are negative – we won't go there

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Data Storage: storing letters

- Letters or characters, are stored as numbers but are encoded so that for each character on the keyboard, there is a positive number that represents that character.
- The standard encoding ASCII
  - American Standard Code for Information Exchange
- Look up www.asciitable.com
- Look up http://unicode-table.com/en/

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File Storage

- Files can be stored on a computer as either plain text or binary.
- HTML files are plain text
- Most image files are binary

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File Sizes

- File sizes are typically quoted in bytes, kilobytes. Megabytes, gigabytes

- 1 byte (B) = 8 bits
- 1 kilobyte (KB) = 1024 bytes = 2^{10} bytes
- 1 megabyte (MB) = 1024 KB
  = 1024 X 1024 bytes
  = 2^{10} X 2^{10} bytes
  = 2^{20} bytes

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File Sizes

- 1 gigabyte (GB) = 1024 MB
  = 1024 X 1024 X 1024 bytes
  = 2^{10} X 2^{10} X 2^{10} bytes
  = 2^{30} bytes

- Don’t mix up your bits and bytes

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Bandwidth

- Bandwidth = speed of data transmission
- Data is transmitted at speeds that are measured in terms of **kilobits** per second (kbits/s)
- 1 **kilobit** = 1000 bits = 10^3 bits ~ 1024 bits = 2^7 bytes
  - The time it takes to **download** a file (copy it from one computer to another) depends on the speed of the network mostly. (As well as speed of source and destination computers)

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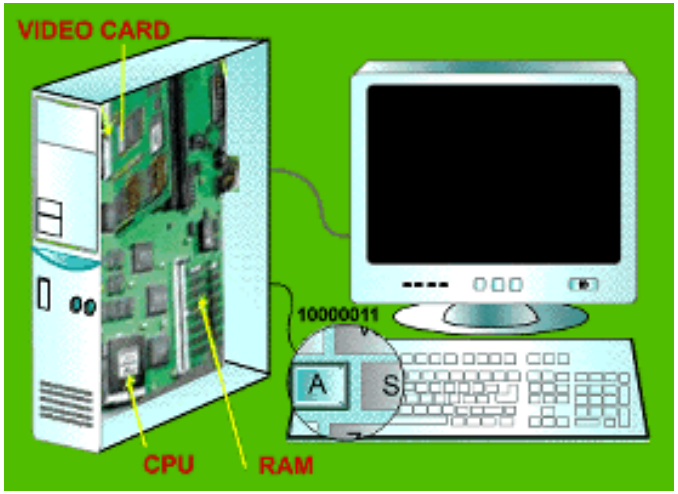
What is Digitization ?

- Digitization refers to the process of translating a piece of information (book, sound recording, picture or video) into binary bits.
- Bits
  - short for Binary Digit



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What is Digitization ?

- Electronic hardware is either “On” or “Off”
- Binary system (base 2)
- Has two digits “0” and “1”
- Electric signals translate into “BITS”

Digits “0” and “1”

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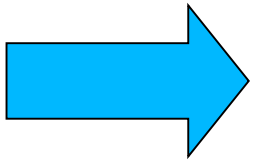
What is Digitization ?

Based on 8bits Binary

- Binary system
- Has two digits “0” and “1”
  - A byte is collection of 8 bits So with 8 bits there are (2^8)= 256 possible combinations of 0s and 1s
  - 2^1 = 2 values (0, 1)
  - 2^2 = 4 values (00,01,11,10)
  - 2^3 = 8 values
  - 2^4 = 16 values
  - 2^8 = 256 values



@	0100 0000
A	0100 0001
B	0100 0010
C	0100 0011
D	0100 0100
E	0100 0101
F	0100 0110
G	0100 0111
H	0100 1000
I	0100 1001
J	0100 1010
K	0100 1011
L	0100 1100
M	0100 1101
N	0100 1110
O	0100 1111
P	0101 0000
Q	0101 0001
R	0101 0010
S	0101 0011
T	0101 0100
U	0101 0101
V	0101 0110
W	0101 0111
X	0101 1000
Y	0101 1001
Z	0101 1010

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Digitization

- Digitization is the process of converting a signal from analogue to digital form

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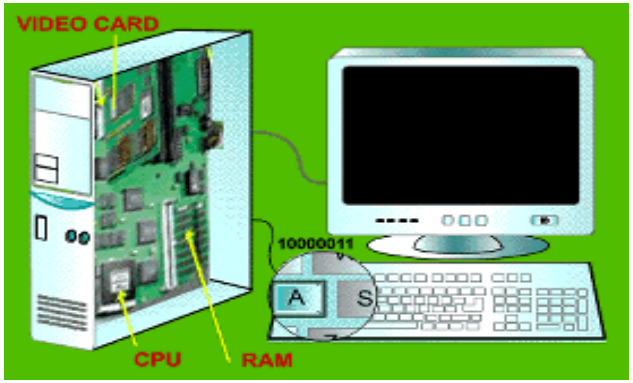
What is Digitization ?

- Analogue data must be converted to a digital form before it can be manipulated by a computer program.
- Digitization consists of two operations:
  - Sampling
  - Quantization



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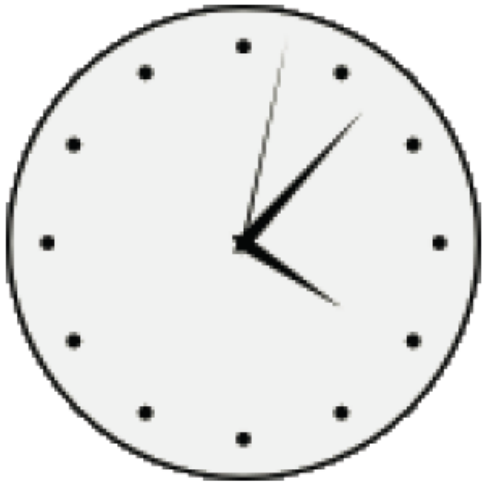
What is Digitization ?

- Analogue and Digital Representations



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Analog to Digital Recording

- Microphone converts sound into an electrical signal
- Continuously varying electrical energy is an analog of the sound pressure wave.
- ADC (Analog to Digital Converter) converts analog to digital electrical signal.
- Digital signal transmits binary numbers.
- http://www.youtube.com/watch?v=YTZcSaPn92s

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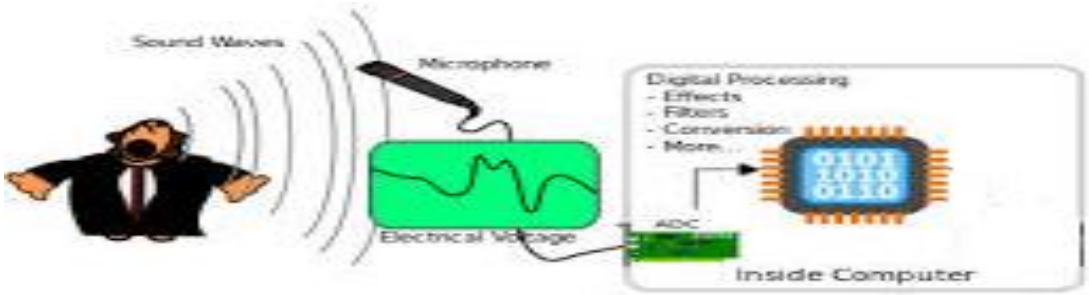
Stages Involved in Digitizing Sound

- A person shouts generating a sound wave
- A microphone is used to capture the sound. The foil in the microphone vibrates generating an electrical wave that mimics the natural sound wave
- The microphone is plugged into an ADC. The ADC takes the analogue electrical sound wave and converts it into a digital form.
- We will now look at how stage 3 is achieved.



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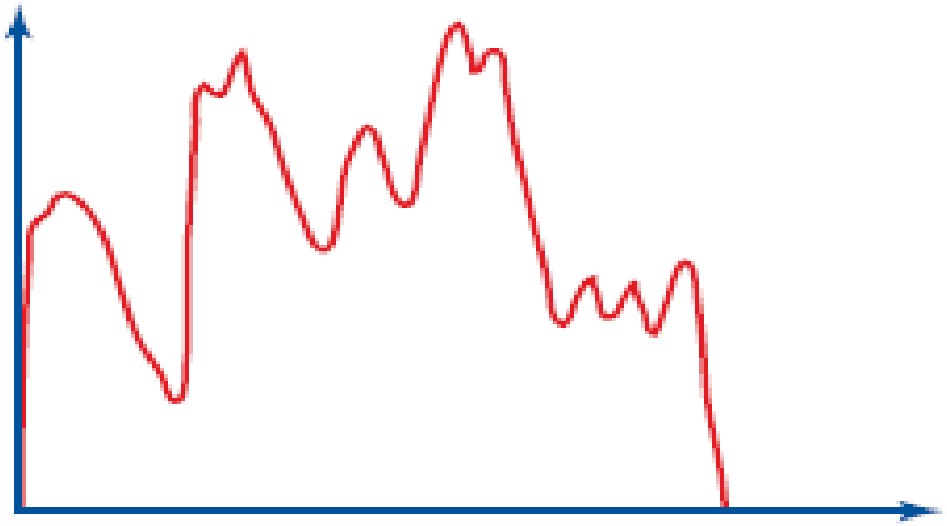
What is Digitization ?

- An Analogue Signal



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Sampling and Quantization

- Sampling and Quantization is normally carried out by Analogue to Digital Converters (ADCs)
- The sampling rate specifies the number of samples to be taken in a fixed amount of time e.g. 16 samples per second
- The quantization rate specifies the number of intervals (horizontal lines) the analogue values can have. In the previous example there were 7)

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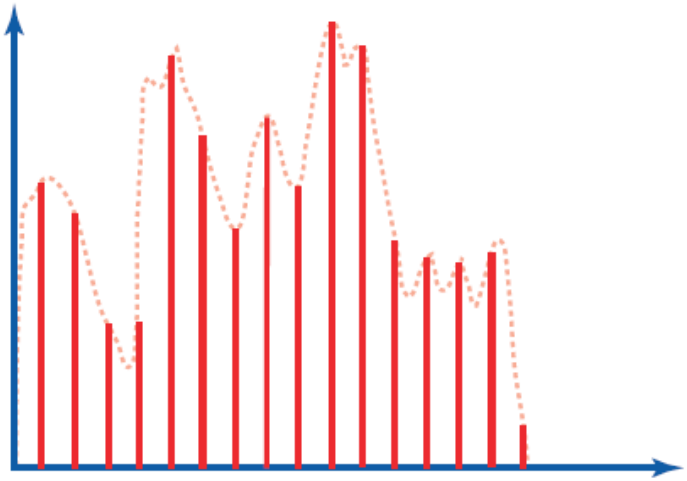
Sampling

- **Sampling**: How many samples will we take to estimate the Analogue signal. In this case there are 16 samples taken



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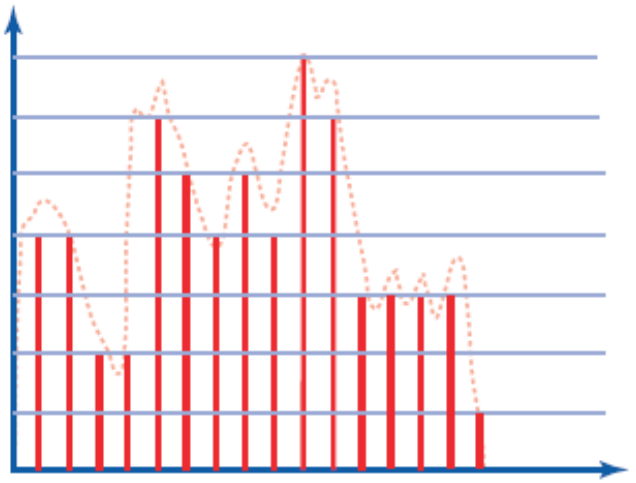
Sampling and Quantization

- Quantization : What is the value of each of the samples?
- There are set values the signal can have.
- Like rounding a number to the nearest integer 60.4 is rounded to 60. 60.6 is rounded to 61.



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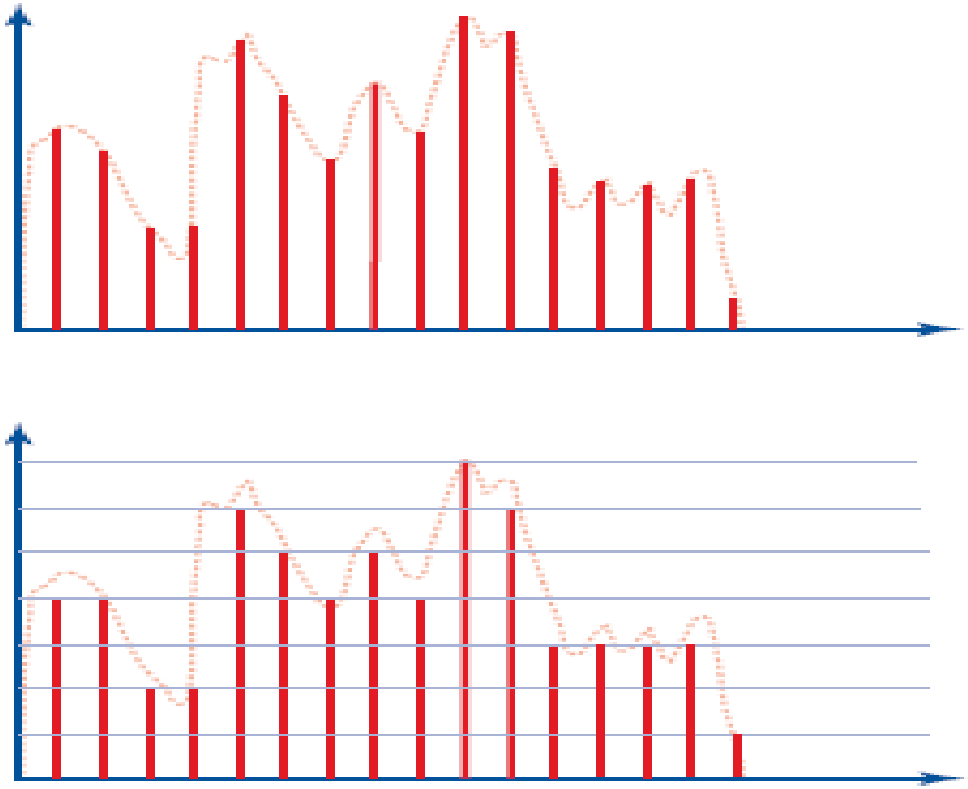
What is Digitization ?

- Sampling and Quantization



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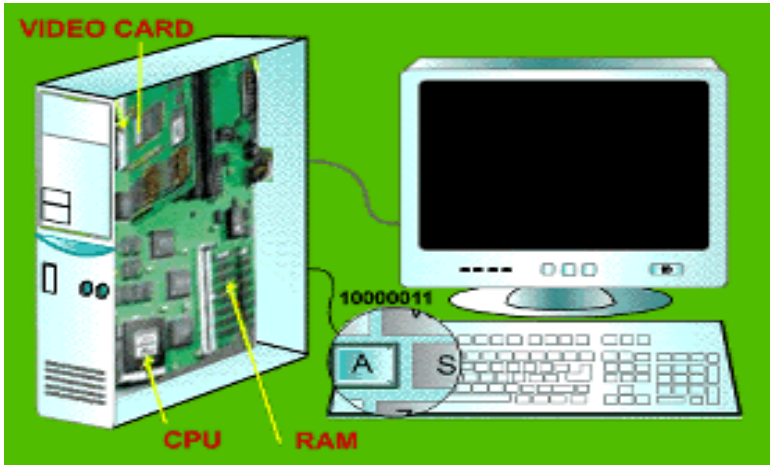
What is Digitization ?

- The **Sampling rate** is the amount of samples in a fixed amount of time
- The **Quantization levels** are the set of values to which a signal is quantized:



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What is Digitization ?

- Using too few quantization levels leads to posterization and Moire Effects in Images, or quantization noise in sound.

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What is Digitization?

- Quantization Noise Demo

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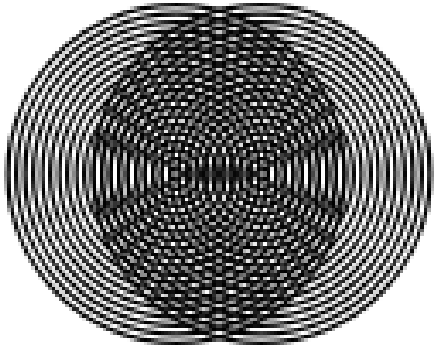
Moiré Pattern

- Moiré effect can produce interesting and beautiful geometric patterns.
- However, the phenomenon degrades the quality and resolution of graphic images.
- Moiré patterns are often an undesired effect of under sampling in digital imaging.



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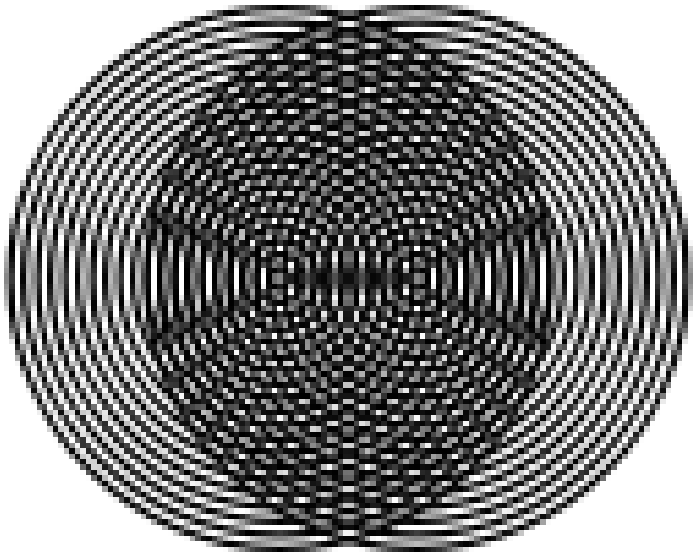
Moiré Pattern



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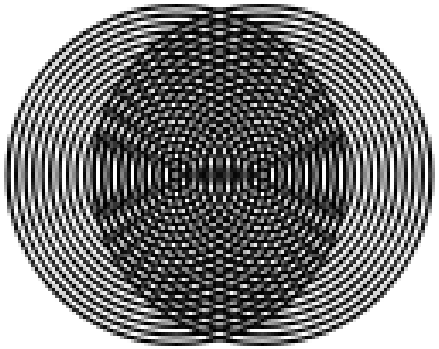
Moiré Pattern



- There are insufficient samples to distinguish between the stripe and the gap between the stripe resting and beautiful geometric patterns.
- However, the phenomenon degrades the quality and resolution of graphic images.
- Moiré patterns are often an undesired effect of under sampling in digital imaging.

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What is Digitization ?

Posterization

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Posterization

- Posterization of an image entails conversion of a continuous gradation of tone to several regions of fewer tones, with abrupt changes from one tone to another.

- Under sampling means there are insufficient samples to pickup gradual changes in colour

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Data Compression

- Compression must often be applied to media data.
- Compression may be lossless or lossy.

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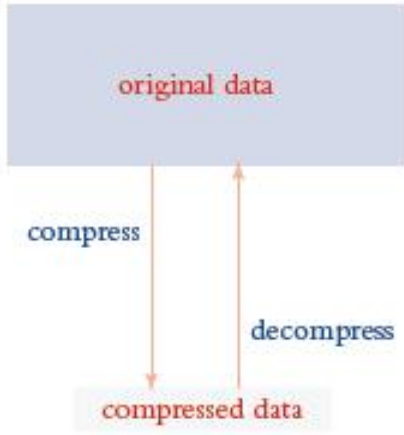
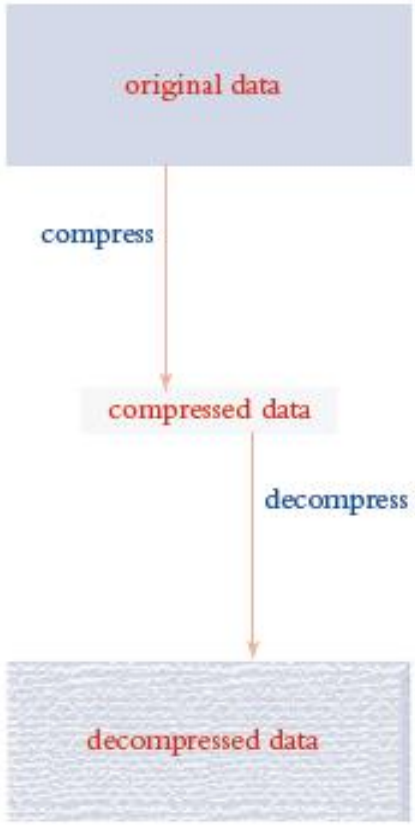
Data Compression



Lossless compression



Lossy compression

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Data Compression

- Different compression algorithms are applicable to different types of media data.
- Their effectiveness depends on the characteristics of the data itself.

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Media Representation

- There are established ways or representing images, video animation sound and text in bits.

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Media Representation

- Media data may be represented as a textual description in a suitable language, or as binary data with a specific structural form.

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Media Representation - Images

- Images are displayed as arrays of pixels and represented using an internal model.
- Generating the pixels from the model is called rendering.

Media Representation - Images

An image made up of pixels

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Media Representation Moving Pictures

- Moving pictures can be created as a live-action or animation.

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Media Representation Moving Pictures

- Live-action must be store as video.
- Animation may be represented in one more flexible or efficient ways.

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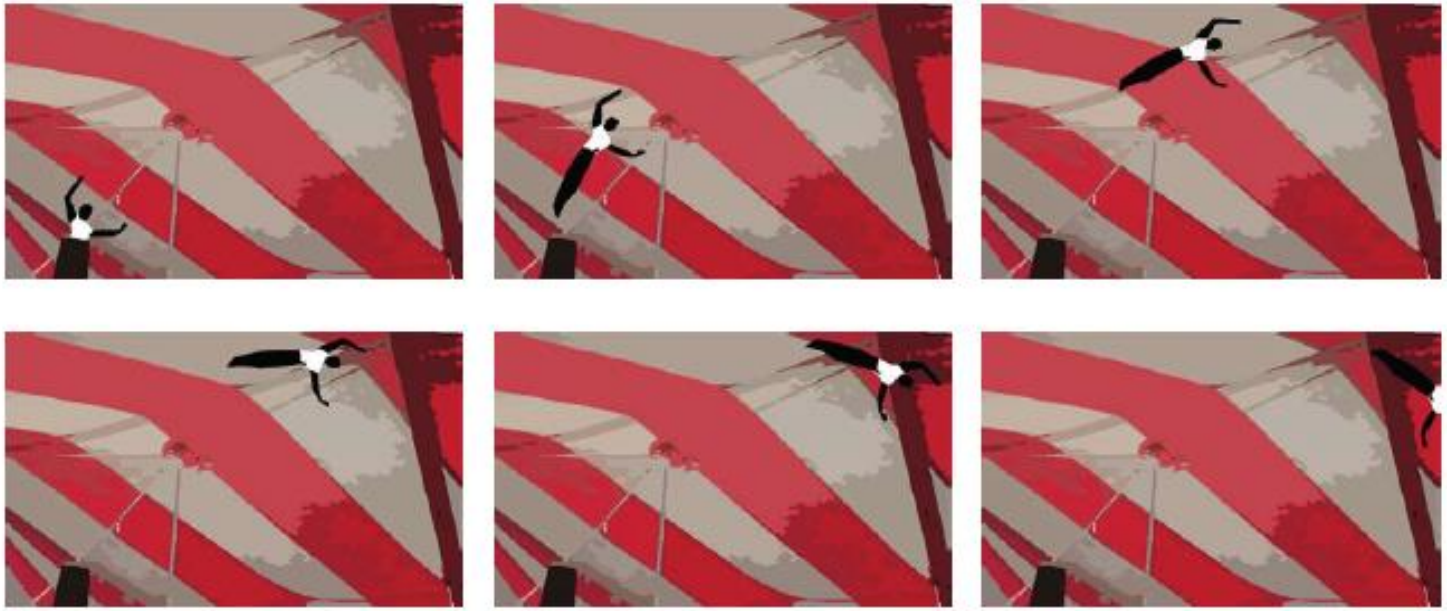
Media Representation Moving Pictures



Frames from an animation

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Media Representation Moving Pictures

- Video frames require a lot of storage so video is invariably compressed for delivery.

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Media Representation Sound

- Sound can be represented as a sequence of samples after digitization.

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Media Representation Sound

- CD audio is sample at 44.1 kHz, higher sampling rates are sometimes used.
- Audio deliver over the internet is compressed, often using the MP3 codec.

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Media Representation Characters

- A character set is a mapping from characters to character codes.
- Unicode is a character set capable of representing text in all known languages

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Media Representation Characters

- A font is a set of character shapes.
- These are called glyphs.

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Transmission of Digital Data

- Media such as copper wires and optical fibres transmit time-varying signals
- Digital information must be encoded for transmission.

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Transmission of Digital Data

- A group of bits (e.g. a character) can be transmitted as a sequence of pulses where the signal is set to 1 or 0 for the duration of each pulse

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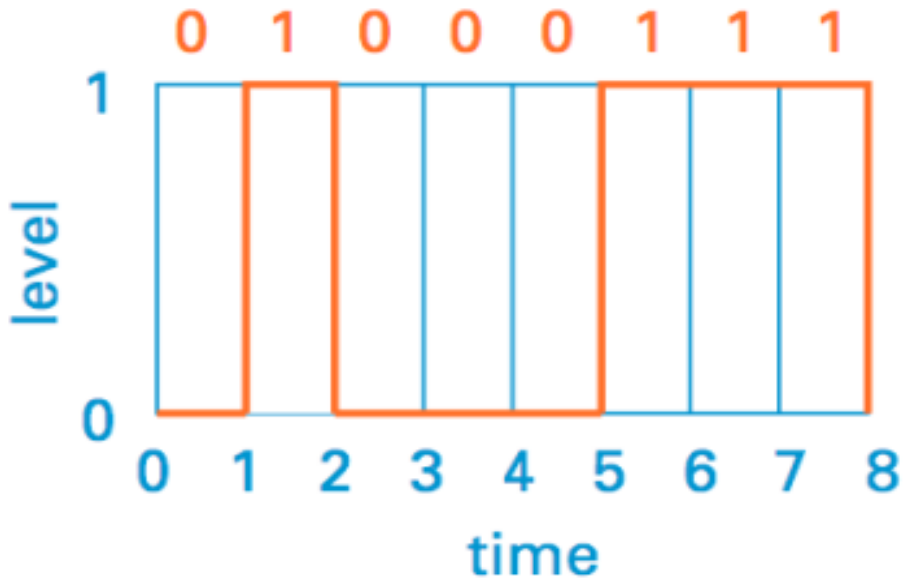
Transmission of Digital Data



Digital data as a train of pulses

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Transmission of Digital Data

- There is always a limit as to how many bits per second can be sent over any physical medium.

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Questions

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