

# Enabling Technologies

## Chapter 2

Digital Multimedia, 2nd edition

# Remember Bits and Bytes?

- Bit: 0 or 1, on or off, ...
- Byte: eight bits, one character
- 1000 Bytes (1KB)
  - 75KB          Low resolution image (640X480)
- 1,000,000 Bytes (1MB)
  - 5MB          4 minute song (MP3)
- 1 billion Bytes (1GB)
  - 3GB          100 minutes DVD quality video

# Interpretation of Bits

- Numbers to base 2 (binary)
  - $01100001 = 97$  decimal
- Characters – associate bit patterns (numbers) with characters via a character set
  - $01100001 = a$  in ASCII
- Brightness of an image at a point,
- instantaneous amplitude of a sound wave, etc

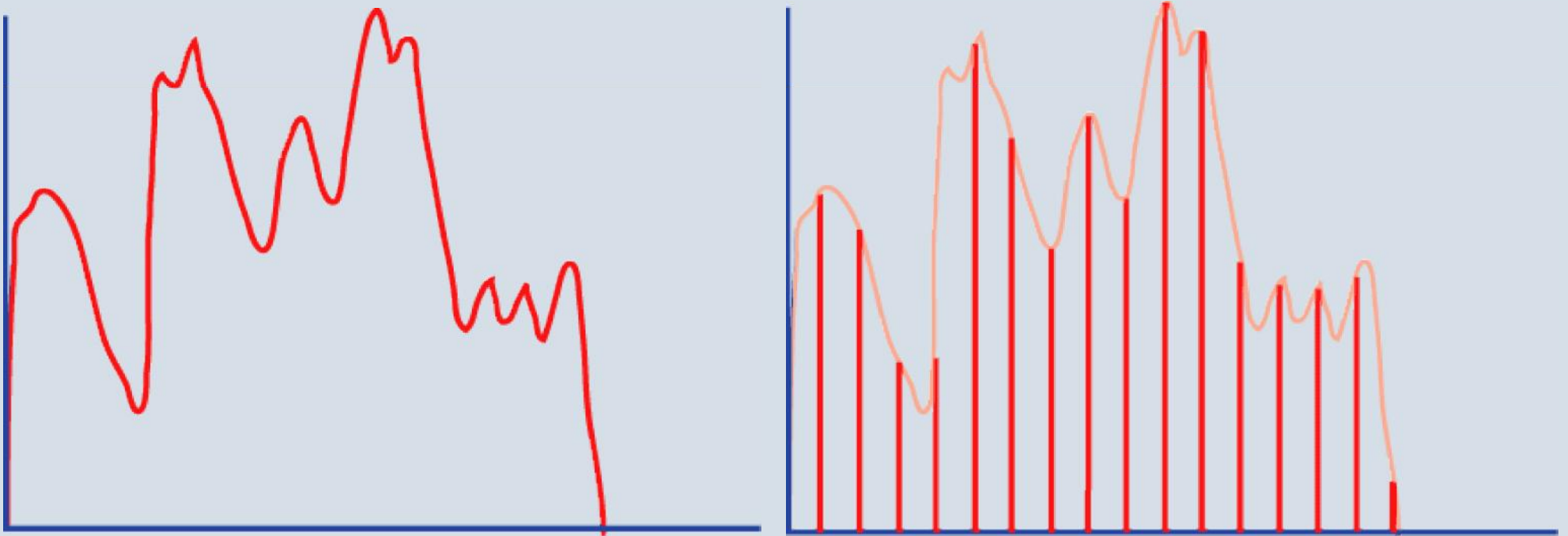
# Addresses

- Each byte can be identified by its position in the sequence of all bytes in memory – its address
- Collections of bytes can be combined into data structures using addresses
  - e.g. store an image as a sequence of brightness values, use address of the first to access the image data
  - store a video sequence as series of images, add address of next and previous to each frame

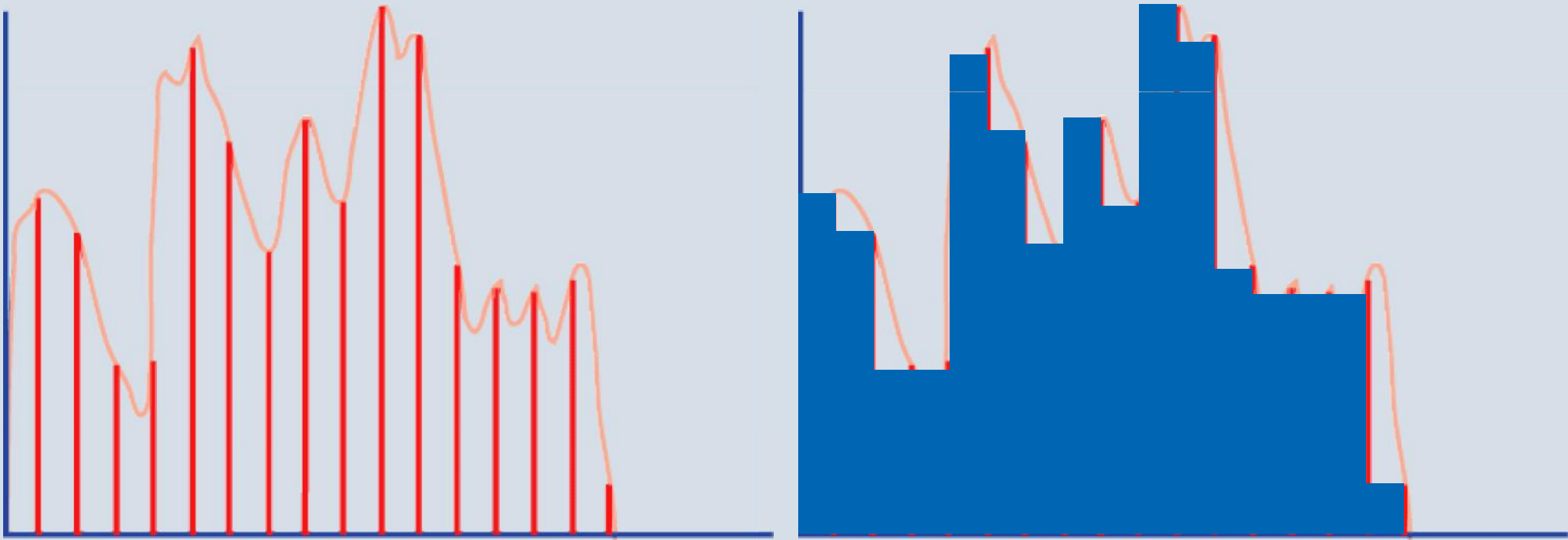
# Digitization

- Converting a signal from analogue to digital form
  - Analogue signal can vary continuously, digital is restricted to discrete values
- Two-stage process
  - Sampling – measure the value at discrete intervals
  - Quantization – restrict the value to a fixed set of quantization levels

# Sampling and Quantization



# Sampling and Quantization

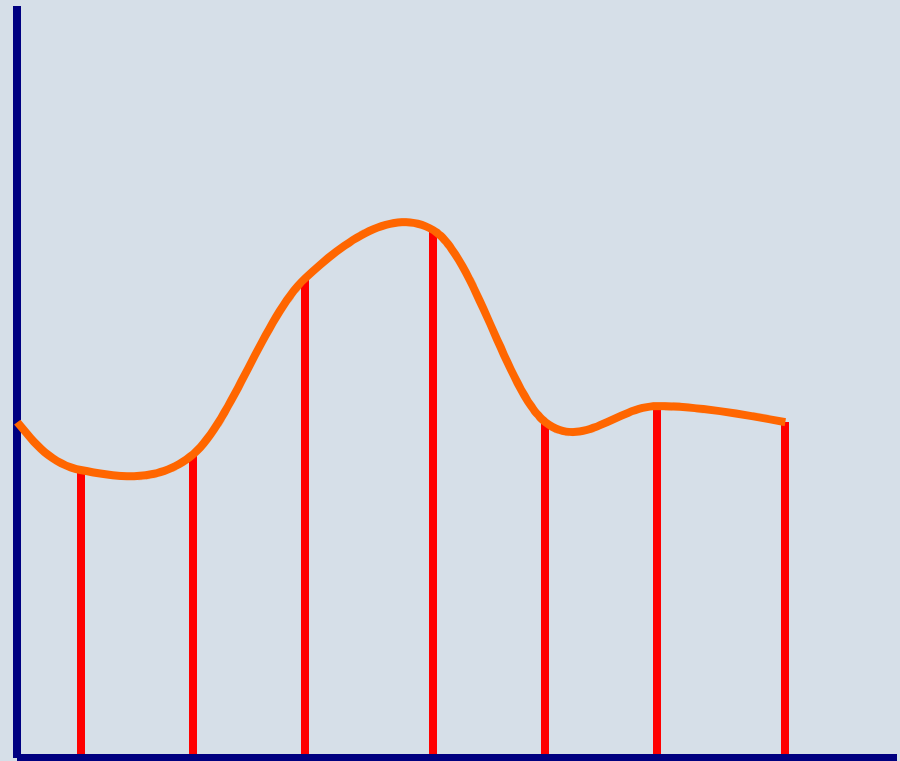
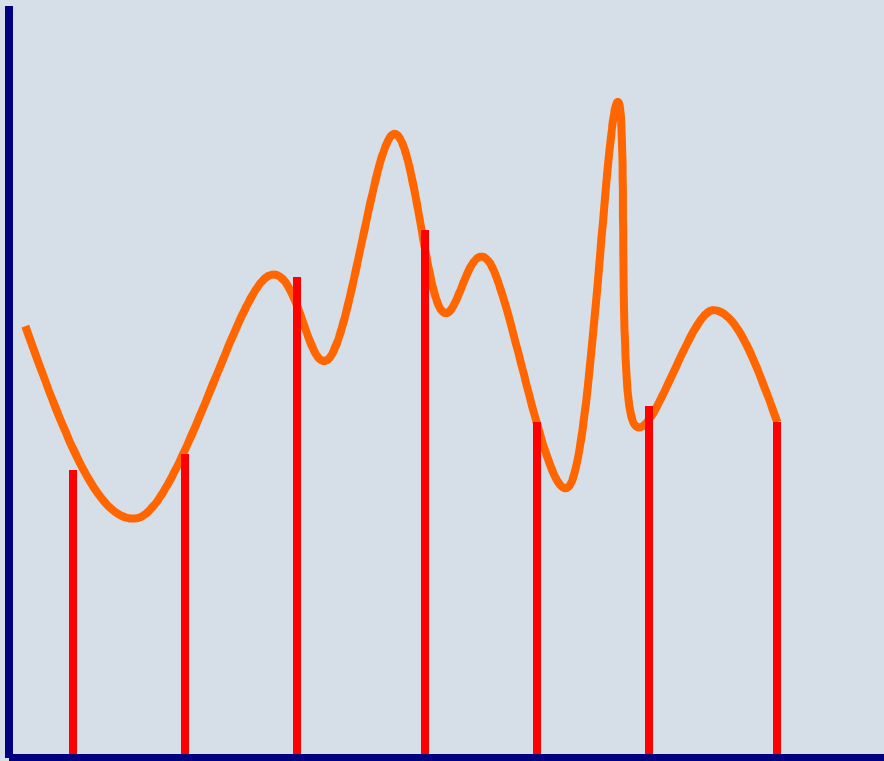


# Digital Signals

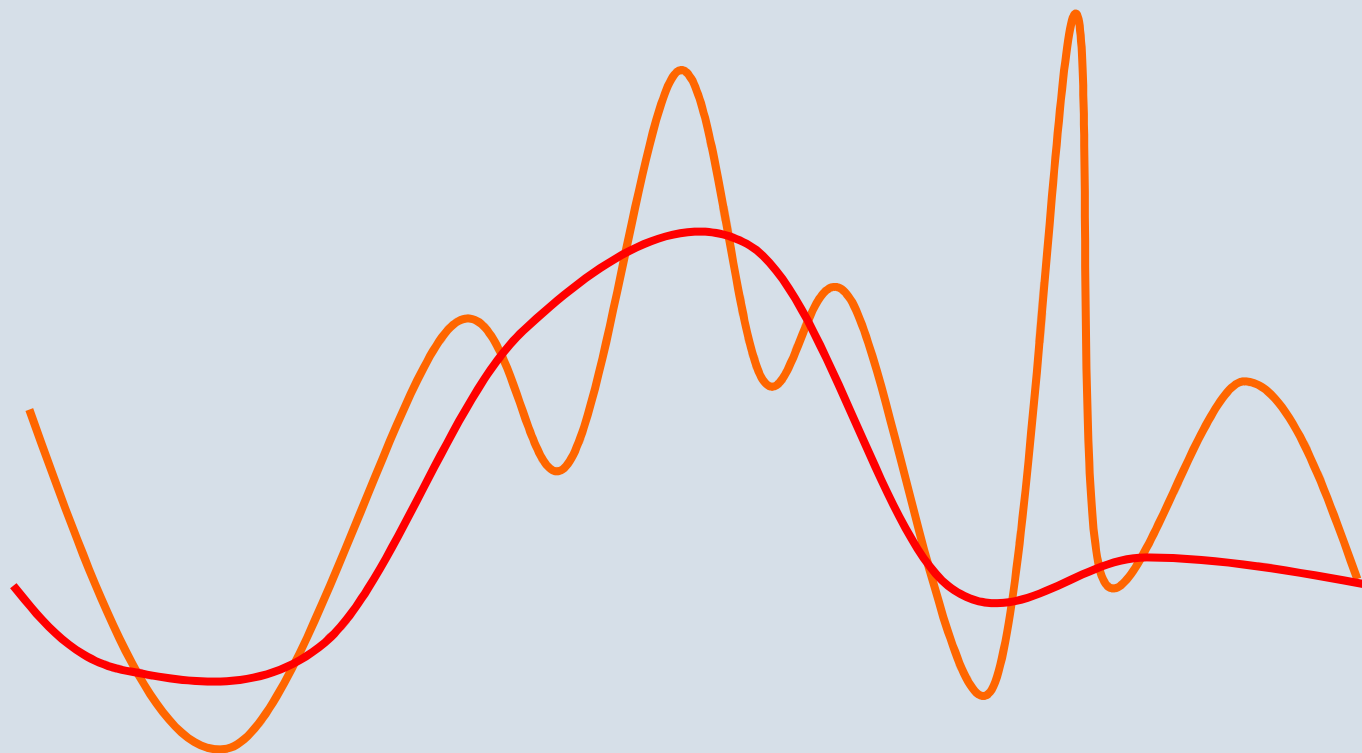
- Only certain signal values are valid
  - Relatively immune to corruption by noise
  - Do not degrade when copied or transmitted over network
- Some information lost
- Undersampling
  - Samples 'too far apart' so cannot accurately reconstruct original signal



# Under-sampling



# Under-sampling



# Frequency Domain

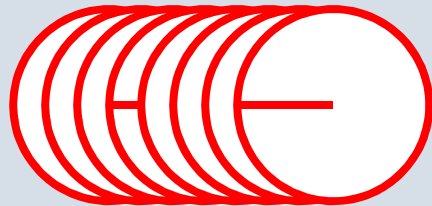
- Any periodic waveform can be decomposed into a collection of frequency components
  - Each component is a pure sine wave specified by amplitude, frequency, etc.
  - $f_h$  is highest frequency of any component
  - The signal can be properly reconstructed if it has been sampled at a frequency  $> 2f_h$

# Sampling Theorem

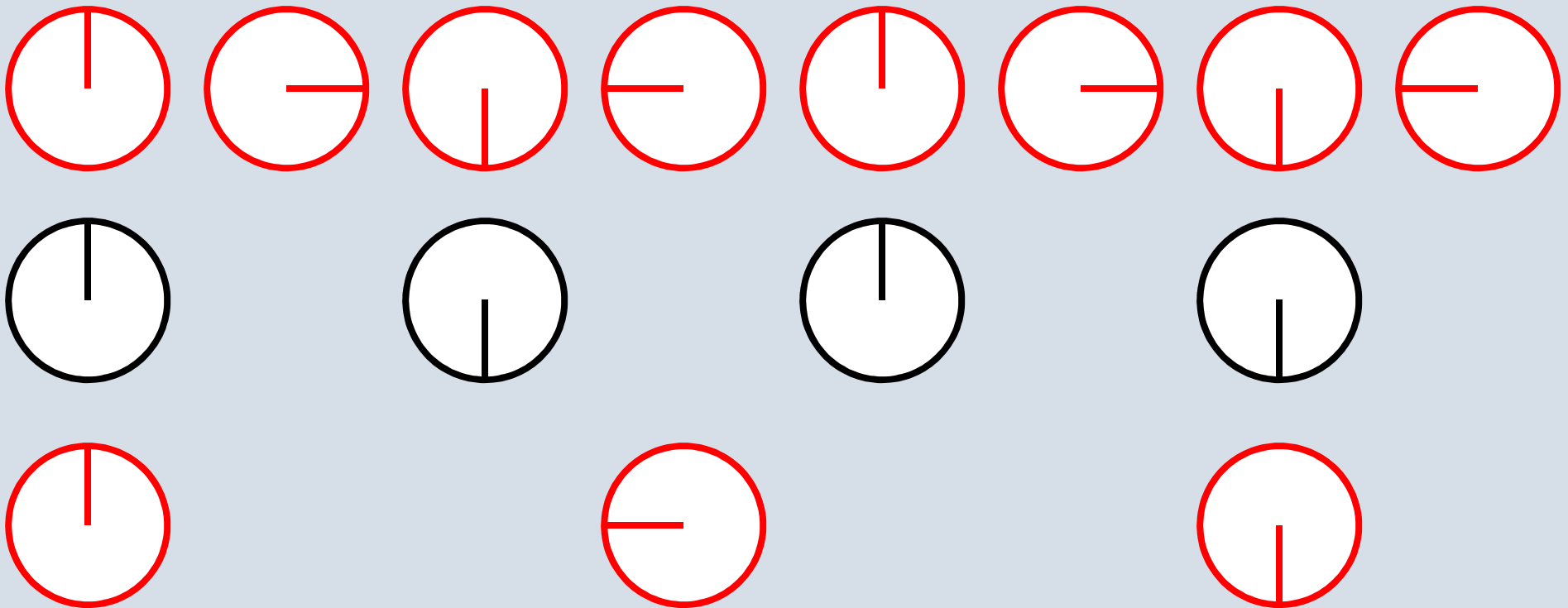
- Undersampling leads to aliasing
  - Sound distortion
  - image 'jaggies' or Moiré patterns
  - jerky or retrograde motion

# Video Sampling

- Second hand – sampled every 15 seconds



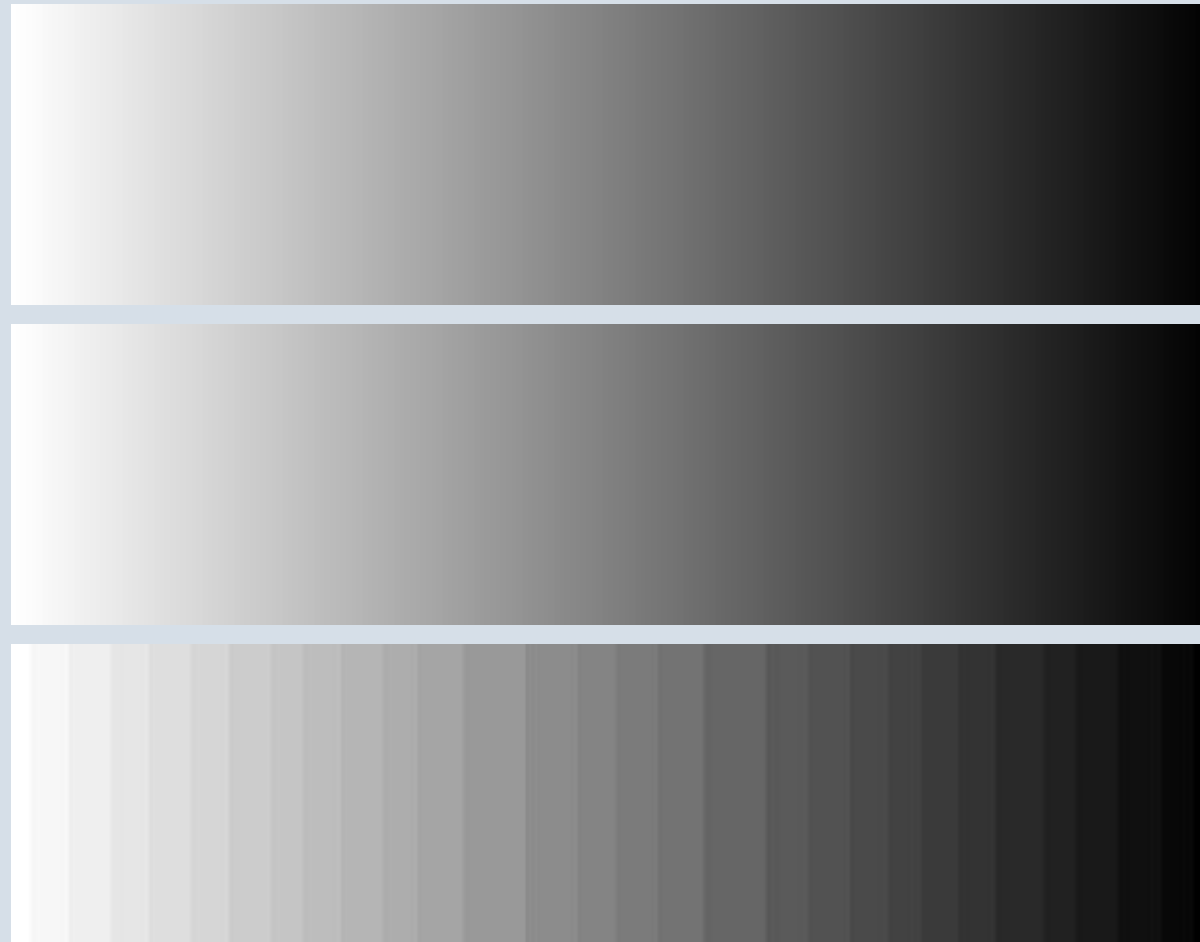
# Under-sampling Video



# Over-sampling

- Audio: Can not tell 100 KHz from 200 KHz
- Video: Can not tell 60 fpm from 120 fpm
- Images: Can not tell 512 shade-gradient from 1024 shades.
- Over sampling means you use extra bits, memory, but humans don't see any increase in quality, precision, etc.

# Over-sampled / Under-sampled





# Too Few Quantization Levels

- Reducing memory requirements by using fewer bits for each value means fewer quantization levels are available
- Cannot distinguish between values that fall between levels
- Images: banding and posterization
- Sound: coarse hiss, loss of quiet passages, general fuzziness (quantization noise)

# Hardware Requirements

- Consumption
  - Capabilities of typical consumer systems determine limits of what is feasible
  - Mobile devices may impose even tighter limitations
- Production
  - Highly demanding on processor power, memory, secondary storage (especially for video)

# Peripherals

- High capacity disks connected via high speed buses
  - Firewire 400, Firewire 800, USB 2.0, SCSI III
  - RAID arrays
- Graphics tablet and pressure-sensitive pen
- High-resolution monitor
- Digital camera, scanner, DV camera,...

# Software Requirements

- Applications for different media types
  - Images: image editing, painting and drawing (Photoshop, Illustrator)
  - Text: editors, layout programs
  - Video: editing and post-production (Premiere, After Effects, Final Cut Pro)
  - Animation: drawing, interpolation (Flash)
  - Sound: editing and effects (Audition, Bias Peak)

# Software Requirements

- Applications for combining media types
- 'Authoring systems'
  - Timeline-based (e.g. Director)
  - Markup-based for WWW (e.g. Dreamweaver)
- May require some programming in a scripting language to provide interactivity
  - Behaviours provide prefabricated parameterized actions

# Networks

- Local area networks (LANs) connect several computers on one site (Ethernet)
- LANs connected together by routers, bridges and switches form an internet
- The Internet is a global network of networks (internet) communicating via TCP/IP protocols
  - Mostly operated by commercial Internet Service Providers (ISPs)
  - Domestic users connect via telephone, cable or satellite

# Internet Access

- Dial-up connection uses modem and analogue telephone line
  - V90 modem, 56kbps maximum
- Broadband always-on digital connection (may be as little as 512kbps, not true broadband)
  - ADSL
  - Cable
  - Satellite
- Dedicated line (T1, T3)

# Download Times

	kbps (max)	100kB image	100kB image	4MB movie
slow modem	28.8	1.5s	28s	19mins
fast modem	56	1s	14s	9mins
T1 line	1544	<1s	1s	21s
Typical broadband	6000	<1s	<1s	5s
T3 line	44736	<1s	<1s	1s



# Clients and Servers

- Servers listen on a communication channel for requests from clients and send responses
  - Often servers (the programs) run on dedicated machines, also referred to as servers
  - Clients run on separate machines (e.g. desktop computer)
- Interaction is governed by protocols

# The World Wide Web

- HTTP – Hypertext Transfer Protocol
- Client (Web browser) sends request for a Web page, server returns it (HTML document)
- Identify server and location of page from a URL
- `http://domain name/path`
  - e.g. `http://www.digitalmultimedia.org/DMM/index.html`
- Server may create page dynamically
  - Communicates with other program via CGI etc

# MIME Types

- Need to identify the type of media data in a data stream in a platform-independent way
- MIME (Multipurpose Internet Mail Extension)
  - Originally designed to allow inclusion of data other than text in email, adopted by HTTP
  - Content-type: type/subtype
  - Types include text, image, audio, video, application, subtypes define specific formats
  - e.g. text/html, image/gif

# Standards

- "Standards are documented agreements containing technical specifications ... to be used consistently ... to ensure that materials, products, processes and services are fit for their purpose" (ISO)
- Ensure things that conform to standards are interchangeable
- Multimedia standards concern file formats, markup languages etc, and especially network protocols

# Standards Organizations

- ISO (International Organization for Standards)
  - All technical fields except electrical and electronic engineering
- IEC (International Electrotechnical Commission)
- ITU (International Telecommunications Union)
  - IT dealt with by joint ISO/IEC technical committee

# Internet Standards

- Internet Architecture Board (IAB)
  - Internet Engineering Task Force (IETF) deals with technical development
  - Internet Assigned Numbers Authority (IANA) registers MIME types, language codes, etc
- World Wide Web Consortium (W3C)
  - No official status, but Recommendations are treated as standards for the WWW