



# Intelligent Signal Processing

## Multimedia Data Representations

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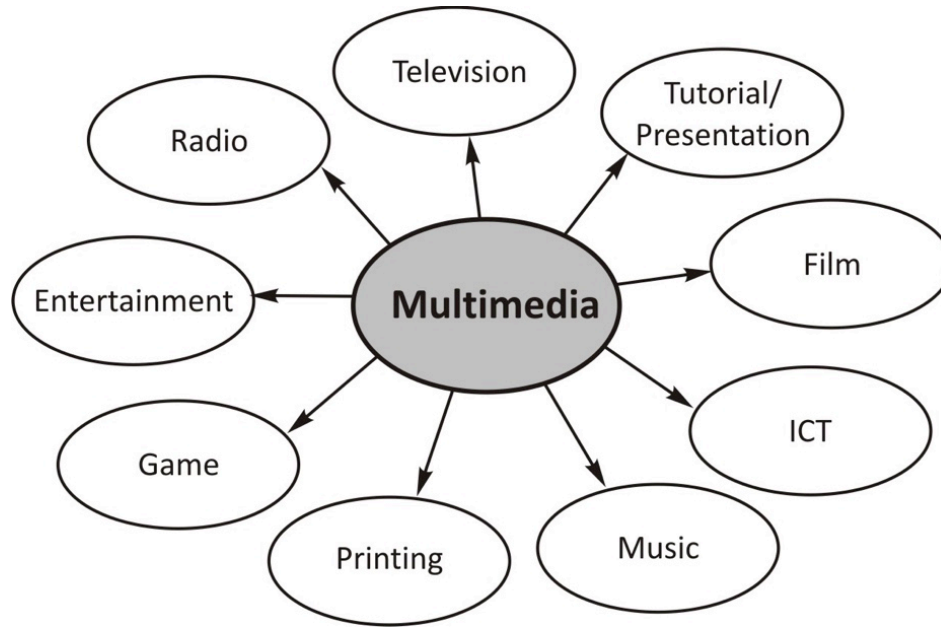
# Multimedia

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- **Multimedia** “etymology” can be interpreted as “**Multi**” - “**Medium**”
- The term **Multimedia** was first known in **the theater world**
  - performance using movement, music, and videos to add to the dramatization of a story
- **Multimedia** data consist of **continuous-media** (audio and video) data as well as conventional files



# Multimedia



Multi-Medium



# Multimedia

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- The term Multimedia means a document containing two or more **media** and **modalities**
  - text
  - images
  - drawings
  - graphics
  - animation
  - video
  - sound (including speech)
  - interactivity ...



# Representations

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- We focus on the representations of
  - Images
  - Video
  - Audio
  
- Successively
  - Data processing
  - Compression



# Data representations

Image	Sound	Video
BMP,	AIFF,	AVI, MOV,
GIF, JPG,	AAC, AC3,	DV, FLV,
EPS, PNG,	MP3, MPG,	MPG,
PICT, PSD,	M4A, MOV,	WMA, WMV,
TIF, TGA	WMA	SWF, M4V, MP4, MXF

Adobe Premier file formats



# Graphics and image data types

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- Images consist of **pixels**
  - picture elements in digital images
- A **1-bit image** consists of *on* and *off* bits
  - Each pixel is stored as a **single bit** (0 or 1)
  - Such an image is also referred to as a **binary image** (1-bit monochrome)



# Monochrome image

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A 640 x 480  
monochrome image  
requires 38.4 kilobytes

Monochrome 1-bit Lena image





# Graphics and image data types

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- A 8-bit image
  - each pixel has a gray value between 0 and 255
  - each pixel is represented by a single byte
  - the entire image can be thought of as a two-dimensional array of pixel values (bitmap)



# Grayscale image

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A 640 x 480  
grayscale image  
requires 300 kB  
of storage (1 byte for  
each pixel)

Grayscale image of Lena



# Graphics and image data types

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- A 24-bit color image
  - each pixel is represented by three bytes, usually representing RGB
  - supports  $256 \times 256 \times 256$  (= 16.777.216) possible combined colors
  - storage penalty - require 921.6 kB of storage without any compression
  - many 24-bit color images are actually stored as 32-bit images - extra byte of data for each pixel storing an  $\alpha$  value representing special-effect information



# 24-bit color image



High-resolution color and separate R, G, B color channel images: a) example of 24-bit color image; (b, c, d) R, G, and B color channels for this image



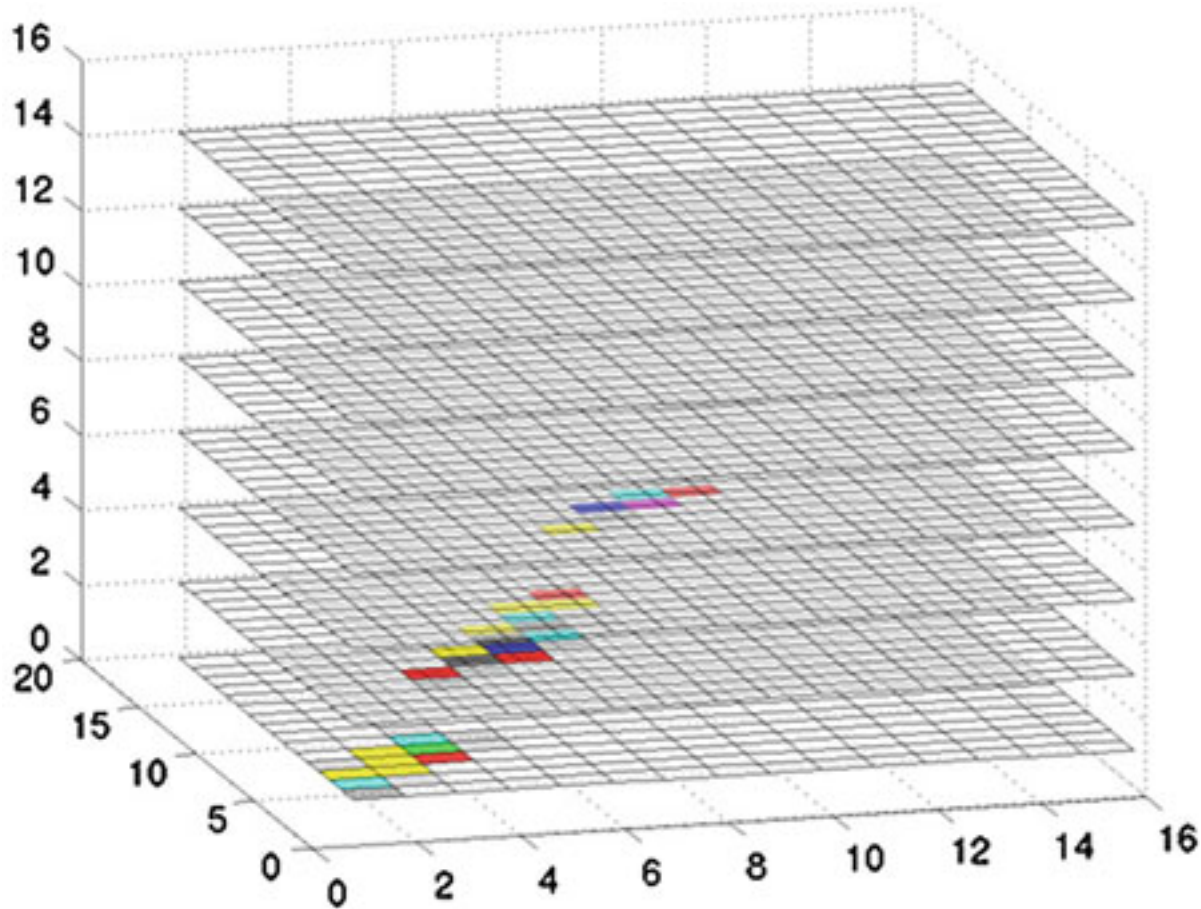
# Graphics and image data types

## ■ 8-bit color images

- if space is a concern, a **quantization** of the color information can be obtained
- use of a **lookup table** to store color information
- the **image** stores not color but just a **set of bytes**
  - each of which is an index into a table with three byte values that specify the 24-bit color for a pixel with that lookup table index
- it makes sense to carefully choose just which colors to represent best in the image
  - use of **color histogram**



# RGB and scatterplot



3D scatterplot of RGB colors



# 8-bit color image

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Example of an 8-bit color image



# Popular file formats - GIF

- **Graphics Interchange Format (GIF)**
  - devised by UNISYS Corporation and CompuServe
  - uses the **Lempel-Ziv-Welch algorithm**
  - limited to 8-bit (256) color images
    - best suited for images with few distinctive colors
  - GIF comes in two flavors
    - **GIF87a**
      - standard
    - **GIF89a**
      - supports **simple animation** via a Graphics Control Extension block in the data





# Popular file formats - JPEG

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- Joint Photographic Experts Group (JPEG)
  - group of the International Organization for Standardization (ISO)
  - color information in JPEG is decimated
  - JPEG allows the user to set a desired level of quality, or compression ratio
- we shall study JPEG in greater detail (i.e., compression algorithms)



# JPEG image

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JPEG image with low quality specified by user



# Popular file formats - PNG

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- **Portable Network Graphics (PNG)**
  - supersede the GIF standard and **extends** it in important ways
  - support for up to **16 bits per pixel in each color channel**, i.e., **48-bit color**
  - files may also contain **gamma-correction information** for correct display of color images
  - $\alpha$ -channel information (up to 16 bits) for such uses as **control of transparency**
  - it supports both **lossless** and **lossy** compression



# Popular file formats - TIFF

- **Tagged Image File Format (TIFF)**
  - developed by the Aldus Corporation in the 1980s
  - **attachment** of additional information
    - format signifier - what type of compression, etc., is in use in the stored image (1-bit, grayscale, 8-bit, 24-bit RGB, and so on)
  - it is quite common to use TIFF files to store **uncompressed data**
    - files are divided into sections, each of which can store a bitmap image, a vector-based or stroke-based image or other types of data



# Popular file formats - BMP

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- **BitMap (BMP)**
  - major system standard image file format for **Microsoft Windows**
  - it uses **raster graphics**
  - it makes use of **Run-Length Encoding (RLE)** compression
    - efficiently compress 24-bit color images due to its 24-bit RLE algorithm
  - BMP images can also be stored **uncompressed**



# Popular file formats - WMF

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- **Windows MetaFile (WMF)**
  - native vector file format for the Microsoft Windows operating environment
  - collection of **Graphics Device Interface (GDI)** function calls
  - When a WMF file is “played” the described graphic is rendered



# Popular file formats - Netpbm

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- Linux/Unix open-source formats
  - PPM (Portable PixMap), PGM (Portable GrayMap), and PBM (Portable BitMap)
  - ASCII files or raw binary files with an ASCII header for images
    - so simple, they can always be used for cross-platform applications



# Popular file formats - EXIF

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- **Exchangeable Image File (EXIF)**
  - image format for digital cameras
  - the recording of image metadata (exposure, light source/flash, white balance, type of scene, etc.) for the standardization of image exchange
  - A variety of tags (many more than in TIFF) is available to facilitate higher quality printing





# Popular file formats - PS and PDF

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- **PostScript (PS)**
  - vector-based picture language
    - page elements are essentially defined in terms of vectors
  - **Encapsulated PostScript (EPS)** files add some information for including PostScript files in another document
- **Portable Document Format (PDF)**
  - Adobe Systems Inc. includes **LZW** compression
  - for files containing images a **JPEG** compression is used

