

Course Code 005636 (Fall 2017)

# Multimedia

Graphics and Image Data Representations (Part 2)

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# Outline

- Graphics/Image Data Types
- Popular File Formats

# Popular File Formats

- **8-bit GIF:**

- Graphics Interchange Format
- one of the most important formats
- the first image type recognized by net browsers.

- **JPEG:**

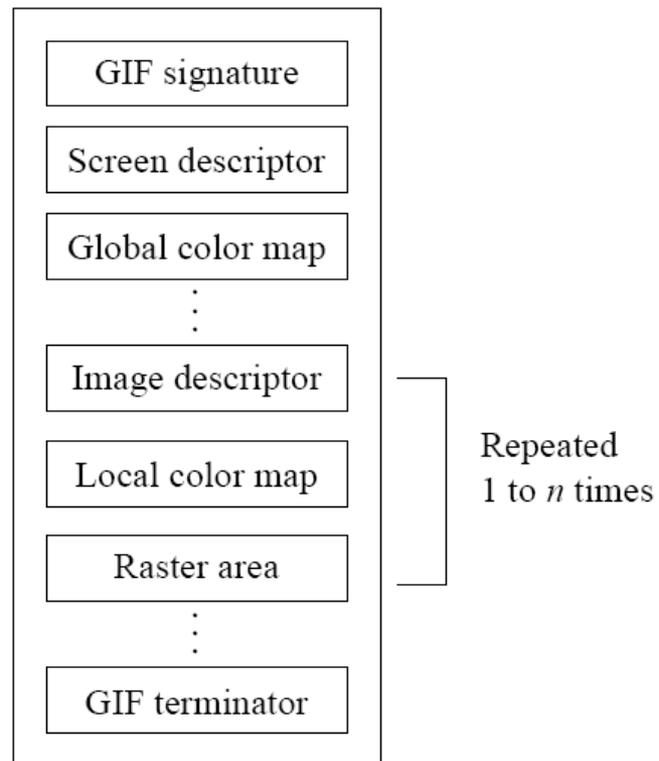
- Joint Photographic Experts Group (a working group of ISO)
- currently the most important standard for image compression.

# GIF

- **GIF standard:** (simple, yet contains many common elements.)
  - limited to 8-bit (256) color images only
  - while producing acceptable color images, it is best suited for images with few distinctive colors (e.g., graphics or drawing)
  - supports **interlacing** — successive display of pixels in widely-spaced rows by a 4-pass display process.
- GIF actually comes in two flavors:
  - 1. **GIF87a:** The original specification.
  - 2. **GIF89a:** The later version. Supports simple animation via a Graphics Control Extension block in the data, provides simple control over delay time, a transparency index, etc.

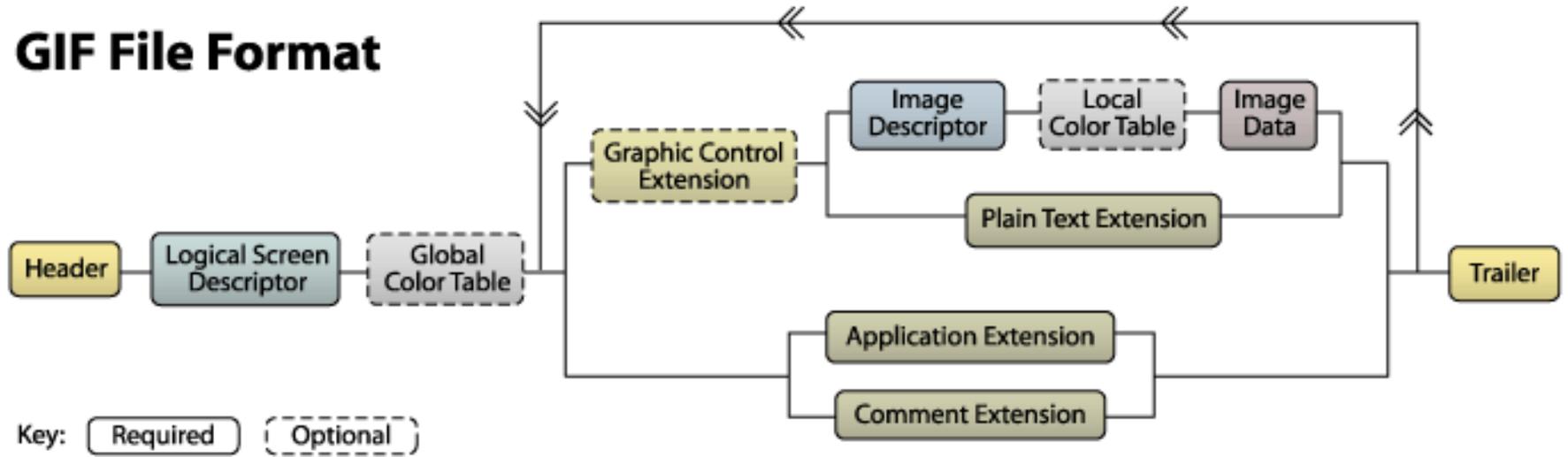
# GIF87a

- The standard specification



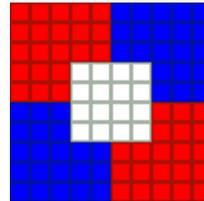
# GIF

## GIF File Format





Actual Size  
(10 x 10)



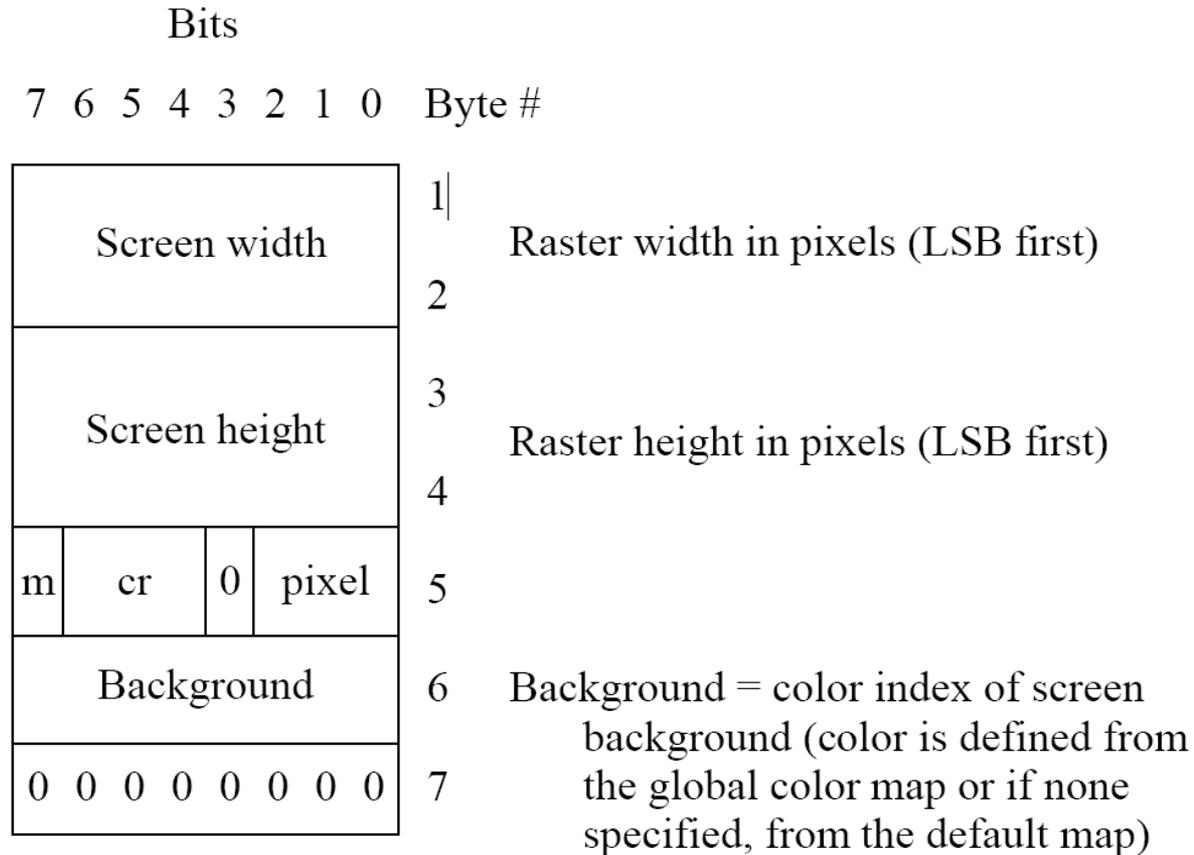
Enlarged

## Bytes

47	49	46	38	39	61	0A	00	0A	00	91	00	00	FF	FF	FF	FF	00	00	00	00	FF	00	00	00
21	F9	04	00	00	00	00	00	2C	00	00	00	00	0A	00	0A	00	00	02	16	8C	2D	99	87	2A
1C	DC	33	A0	02	75	EC	95	FA	A8	DE	60	8C	04	91	4C	01	00	3B						

# GIF87a

- **Screen Descriptor** comprises a set of attributes that belong to every image in the file.



m = 1      Global color map follows descriptor  
 cr + 1     # bits of color resolution  
 pixel + 1   # bits/pixel in image

# GIF87a

## ▪ Color Map

- the actual length of the table equals  $2^{(pixel+1)}$  as given in the Screen Descriptor.

Bits									
7	6	5	4	3	2	1	0	Byte #	
Red intensity								1	Red value for color index 0
Green intensity								2	Green value for color index 0
Blue intensity								3	Blue value for color index 0
Red intensity								4	Red value for color index 1
Green intensity								5	Green value for color index 1
Blue intensity								6	Blue value for color index 1
⋮									(continues for remaining colors)

# GIF87a

- **Image Descriptor**

Bits						Byte #			
7	6	5	4	3	2	1	0		
0	0	1	0	1	1	0	0	1	Image separator character (comma)
Image left								2	Start of image in pixels from the left side of the screen (LSB first)
Image top								3	Start of image in pixels from the top of the screen (LSB first)
Image width								4	Width of the image in pixels (LSB first)
Image height								5	Height of the image in pixels (LSB first)
Image width								6	Width of the image in pixels (LSB first)
Image height								7	Height of the image in pixels (LSB first)
Image height								8	Height of the image in pixels (LSB first)
Image height								9	Height of the image in pixels (LSB first)
m	i	0	0	0	pixel			10	m = 0      Use global color map, ignore 'pixel' m = 1      Local color map follows, use 'pixel' i = 0      Image formatted in Sequential order i = 1      Image formatted in Interlaced order pixel + 1   # bits per pixel for this image

# GIF87a

## Interlace

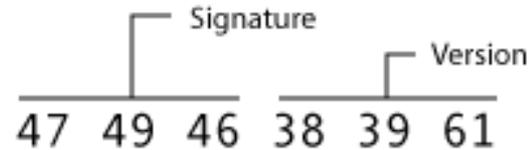
- If the “interlace” bit is set in the local Image Descriptor, then the rows of the image are displayed in a four-pass sequence

Image row	Pass 1	Pass 2	Pass 3	Pass 4	Result
0	*1a*				*1a*
1				*4a*	*4a*
2			*3a*		*3a*
3				*4b*	*4b*
4		*2a*			*2a*
5				*4c*	*4c*
6			*3b*		*3b*
7				*4d*	*4d*
8	*1b*				*1b*
9				*4e*	*4e*
10			*3c*		*3c*
11				*4f*	*4f*
12		*2b*			*2b*
⋮					
⋮					

# GIF Specification Example

47 49 46 38 39 61

## Header

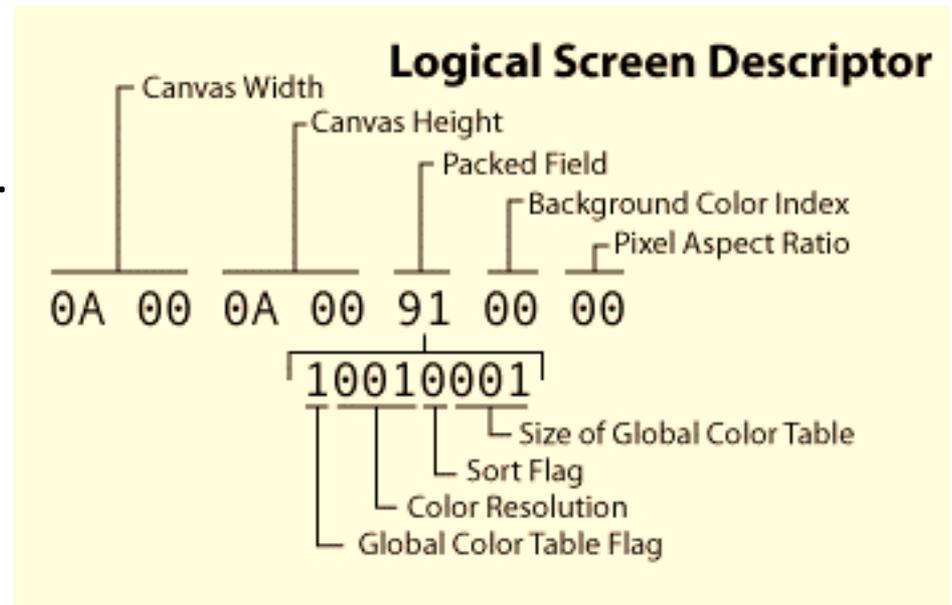


- All GIF files must start with a header block.
- The header takes up the first six bytes of the file. These bytes should all correspond to ASCII character codes.
- The first three bytes are called the signature. These should always be "GIF" (ie 47="G", 49="I", 46="F").
- The next three specify the version of the specification that was used to encode the image.
- Normally the version string will be either "89a" (ie 38="8", 39="9", 61="a") or "87a" (ie 38="8", 37="7", 61="a").
- All modern GIF-processing software recognizes both versions, For maximum compatibility, GIFLIB will normally write an 87a signature unless the file contains GIF89 features.

# GIF Specification Example

- The logical screen descriptor always immediately follows the header.
- This block tells the decoder how much room this image will take up. It is exactly seven bytes long.
- It starts with the canvas (screen) width and canvas height. These value can be found in the first two pairs of two bytes each. Both are 16-bit, nonnegative integers (0-65,535).
- Pixel aspect ratio:  $(N + 15) / 64$

0A 00 0A 00 91 00 00



# GIF Specification Example

- GIFs can have either a global color table or local color tables for each sub-image.

```
FF FF FF FF 00 00 00 00 FF 00 00 00
```

- Each color table consists of a list of RGB (Red-Green-Blue) color component intensities, three bytes for each color, with intensities ranging from 0 (least) to 255 (most).

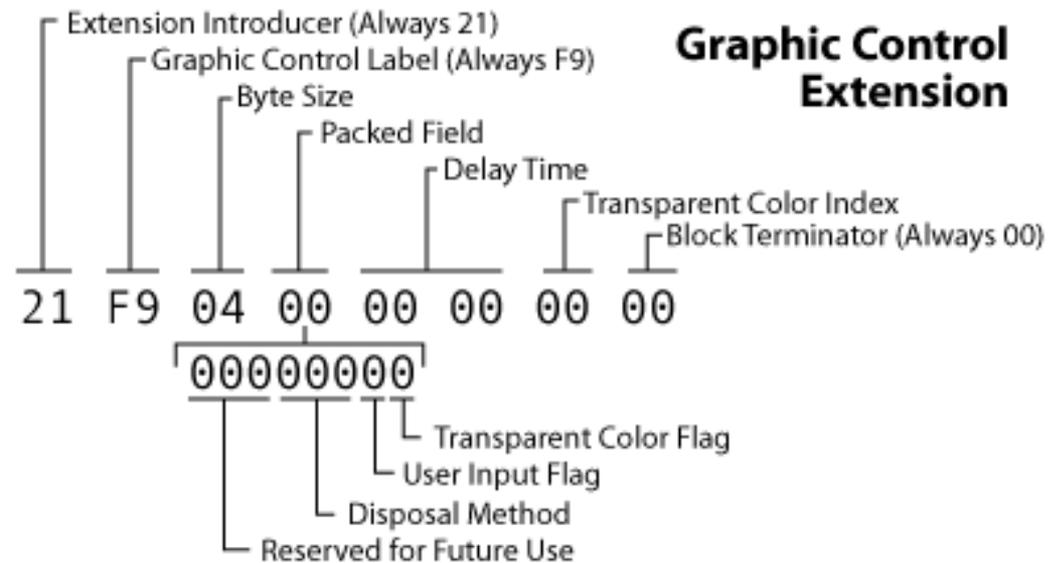


- The color (0,0,0) is deepest black, the color (255,255,255) brightest white.
- The other extreme colors are red at (255,0,0), green at (0,255,0) and blue at (0,0,255).

# GIF Specification Example

- Graphic control extension blocks are used to specify transparency settings and control animations.
- They are an optional GIF89 extension.

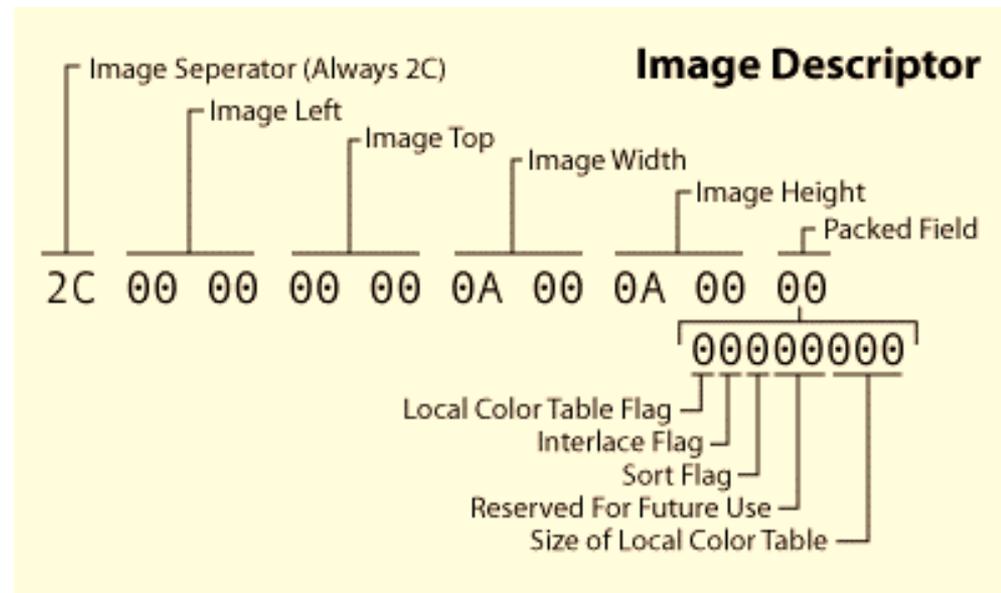
21 F9 04 00 00 00 00 00



# GIF Specification Example

- A single GIF file may contain multiple images.
- Each image begins with an image descriptor block. This block is exactly 10 bytes long.
- The first byte is the image separator. Every image descriptor begins with the value 2C.
- The next 8 bytes represent the location and size of the following image.

2C 00 00 00 00 0A 00 0A 00 00

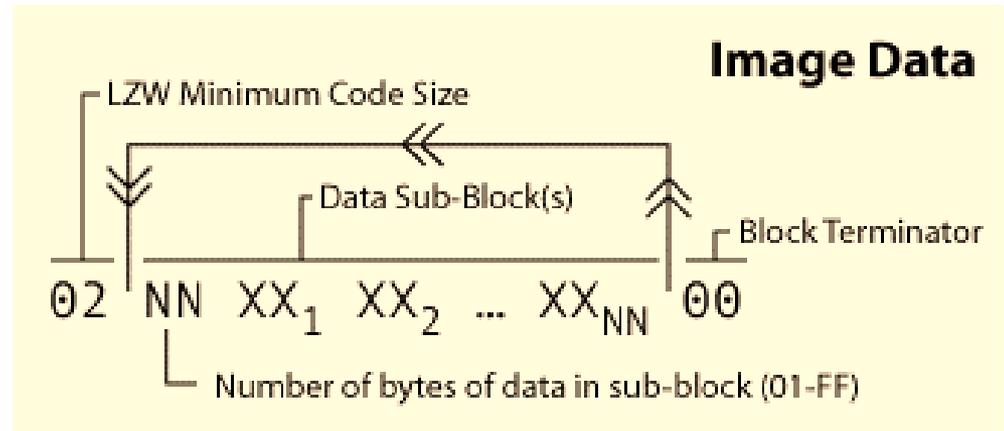


# GIF Specification Example

16 hex = 22

02 16 8C 2D 99 87 2A 1C DC 33 A0 02 75 EC 95 FA A8 DE 60 8C 04 91 4C 01 00

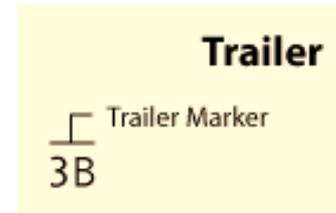
- The image data is composed of a series of output codes which tell the decoder which colors to emit to the canvas.
- These codes are combined into the bytes that make up the block.
- The first byte of this block is the **LZW minimum code size**. This value is used to decode the compressed output codes.
- The rest of the bytes represent *data sub-blocks*. Data sub-blocks are groups of 1 - 256 bytes.



- The first byte in the sub-block tells us how many bytes of actual data follow. This can be a value from 0 (00) to 255 (FF).
- After reading those bytes, the next byte we read will tell us how many more bytes of data follow that one. We continue to read until we reach a sub-block that says that zero bytes follow.

# GIF Specification Example

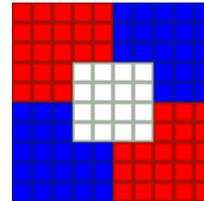
- The trailer block indicates when you've reached the end of the file.
- It is always a byte with a value of 3B.



# GIF Specification



Actual Size  
(10 x 10)



Enlarged

## Bytes

Header{Signature, Version}

Screen descriptor

Global color table

47	49	46	38	39	61	0A	00	0A	00	91	00	00	FF	FF	FF	FF	00	00	00	00	FF	00	00	00
21	F9	04	00	00	00	00	00	2C	00	00	00	00	0A	00	0A	00	00	02	16	8C	2D	99	87	2A
1C	DC	33	A0	02	75	EC	95	FA	A8	DE	60	8C	04	91	4C	01	00	3B	Image trailer					

Image data

Image descriptor

Graphic  
Control  
extension

# Introduction to JPEG

- The human vision system has some specific limitations and JPEG takes advantage of these to achieve high rates of compression.
- JPEG allows the user to set a desired level of quality, or compression ratio (input divided by output).
  - since it is easy to choose how large a denominator to use and hence how much information to discard.
- **e.g., forestfire.jpeg**
  - a JPEG image with a quality factor  $Q=10\%$  yields 1.5% of the original image size.  $Q=75\%$  yields an image size 5.6% , while a GIF image yields an image size 23.0% .



# PNG

- **PNG format (Portable Network Graphics)**

- System independent, stemming from the popularity of the Internet.
- To supersede the GIF standard, and extends it.
- The patent on the LZW compression method.

- Features:

- Support for up to **48 bits** of color information.
- Files may contain **gamma-correction** information for correct display of color images, as well as **alpha-channel** information for such uses as control of transparency.
- The display progressively displays pixels in a 2-dimensional fashion by showing a few pixels at a time over seven passes through each 8 x 8 block of an image.

Transparency



# TIFF

- **TIFF(Tagged Image File Format)** -- flexibility support for attachment of additional information (referred to as 'tags').
  - The most important tag is a format signifier: what type of compression etc. is in use in the stored image.
    - E.g., TIFF can store many different types of image: 1-bit, grayscale, 8-bit color, 24-bit RGB, etc.
- TIFF was originally a lossless format but now a new JPEG tag allows JPEG compression.
- Since TIFF is not as user-controllable as JPEG, it does not provide any major advantages over the latter.

# EXIF

- **EXIF** (Exchange Image File) is an image format for digital cameras:
  - Compressed EXIF files use the baseline JPEG format.
  - A variety of tags (many more than in TIFF) are available to facilitate higher quality printing, since information about the camera and picture-taking conditions (flash, exposure, light source, white balance, type of scene, etc.) can be stored and used by printers for possible color correction algorithms.
  - The EXIF standard also includes specification of file format for audio that accompanies digital images. It also supports tags for information needed for conversion to FlashPix (developed by Kodak).

# Graphics Animation Files

- A few dominant formats aimed at storing graphics animations (i.e., series of drawings or graphic illustrations) as opposed to video (i.e., series of images).
- **Difference:** animations are considerably less demanding of resources than video files.
  1. **FLC** is an animation or moving picture file format; it was originally created by Animation Pro. Another format, FLI, is similar to FLC.
  2. **GL** produces somewhat better quality moving pictures. GL animations can also usually handle larger file sizes.
  3. Many older formats: such as DL or Amiga IFF files, Apple Quicktime files, as well as animated GIF89 files.

# PS and PDF

- **Postscript** is an important language for typesetting, and many high-end printers have a Postscript interpreter built into them.
- Postscript is a vector-based picture language, rather than pixel-based: page element definitions are essentially in terms of vectors.
  - With fonts defined this way, PostScript includes text as well as vector/structured graphics
  - GL bit-mapped images can be included in output files.
  - Encapsulated Postscript files add some additional information for inclusion of Postscript files in another document.
  - Postscript page description language itself does not provide compression; Postscript files are stored as ASCII.

- Another text + figures language has begun to supersede or at least parallel Postscript: Adobe Systems Inc. includes LZW compression in its Portable Document Format (**PDF**) file format.
  - PDF files that do not include images have about the same compression ratio, 2:1 or 3:1, as do files compressed with other LZW-based compression tools.

# Some Other JPEG Formats

- **Microsoft Windows: WMF (Windows MetaFile):** the native vector file format for the MS Windows operating environment:
  - Consist of a collection of GDI (Graphics Device Interface) function calls, also native to the Windows environment.
  - When a WMF file is 'played' (typically using the Windows PlayMetaFile() function) the described graphics is rendered.
  - WMF files are ostensibly device-independent and are unlimited in size.

- **Microsoft Windows: BMP (BitMap):** the major system standard graphics file format for MS Windows, used in Paint and other programs. Many sub-variants within the BMP standard.
- **Macintosh: PAINT and PICT:**
  1. PAINT was originally used in the MacPaint program, initially only for 1-bit monochrome images.
  2. PICT format is used in MacDraw (a vector-based drawing program) for storing structured graphics.
- **X-windows: PPM (Portable PixMap):** the graphics format in the X Window system for storing icons, pixmaps, backdrops, etc. PPM supports 24-bit color bitmaps.

# Q&A

