

# Unit 1

## Digital Content

### Computer Concepts 2016

ENHANCED EDITION



## 1 Unit Contents

- Section A: Digital Basics
- Section B: Digital Sound
- Section C: Bitmap Graphics
- Section D: Vector Graphics
- Section E: Digital Video

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## 1 Section A: Digital Basics

- Data Representation Basics
- Representing Numbers
- Representing Text
- Bits and Bytes
- Compression

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## 1 Data Representation Basics

- Data refers to the symbols that represent people, events, things, and ideas. Data can be a name, a number, the colors in a photograph, or the notes in a musical composition
- Data Representation refers to the form in which data is stored, processed, and transmitted
- Devices such as smartphones, iPods, and computers store data in digital formats that can be handled by electronic circuitry

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## 1 Data Representation Basics

- Digitization is the process of converting text, numbers, sound, photos, and video into data that can be processed by digital devices
- The digital revolution has evolved through four phases, beginning with big, expensive, standalone computers, and progressing to today's digital world in which small, inexpensive digital devices are everywhere

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## 1 Data Representation Basics

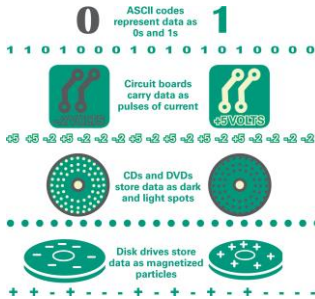
- The 0s and 1s used to represent digital data are referred to as binary digits – from this term we get the word *bit* which stands for *binary digit*
- A bit is a 0 or 1 used in the digital representation of data
- A digital file, usually referred to simply as a file, is a named collection of data that exists on a storage medium, such as a hard disk, CD, DVD, or flash drive

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## 1 Data Representation Basics

FIGURE 1-1: MANY WAYS TO REPRESENT DIGITAL DATA



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## 1 Representing Numbers

- Numeric data consists of numbers that can be used in arithmetic operations
- Digital devices represent numeric data using the binary number system, also called base 2
- The binary number system only has two digits: 0 and 1
- No numeral like 2 exists in the system, so the number “two” is represented in binary as 10 (pronounced “one zero”)

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## 1 Representing Numbers

FIGURE 1-2: BINARY EQUIVALENT OF DECIMAL NUMBERS

DECIMAL (BASE 10)	BINARY (BASE 2)
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
1000	1111101000

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## 1 Representing Text

- Character data is composed of letters, symbols, and numerals that are not used in calculations
- Examples of character data include your name, address, and hair color
- Character data is commonly referred to as “text”

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## 1 Representing Text

- Digital devices employ several types of codes to represent character data, including ASCII, Unicode and their variants
- ASCII (American Standard Code for Information Interchange, pronounced “ASK ee”) requires seven bits for each character
- The ASCII code for an uppercase A is 1000001

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## 1 Representing Text

- Extended ASCII is a superset of ASCII that uses eight bits for each character
- For example, Extended ASCII represents the uppercase letter A as 01000001
- Using eight bits allows Extended ASCII to provide codes for 256 characters

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# 1 Representing Text

- Unicode (pronounced "YOU ni code") uses sixteen bits and provides codes for 65,000 characters
- This is a bonus for representing the alphabets of multiple languages

# 1 Representing Text

FIGURE 1-3: ASCII CODES

01000000	Space	00110011	3	01000110	F	01010001	Y	01011000	I
00100001	!	00110100	4	01000111	G	01011010	Z	01011011	M
00100010	"	00110101	5	01001000	H	01011011	[	01011100	o
00100011	#	00110110	6	01001001	I	01011000	\	01011101	o
00100100	\$	00110111	7	01001010	J	01011011	]	01100000	p
00100101	%	00111000	8	01001011	K	01011100	^	01100001	q
00100110	&	00111001	9	01001100	L	01011111	_	01100010	r
00100111	'	00111010	:	01001101	M	01100000	`	01100011	s
00101000	(	00111011	;	01001110	N	01100001	a	01101000	t
00101001	)	00111100	<	01001111	O	01100010	b	01101001	u
00101010	*	00111101	=	01010000	P	01100011	c	01101010	v
00101011	+	00111110	>	01010001	Q	01100100	d	01101011	w
00101100	,	00111111	?	01010010	R	01100101	e	01110000	x
00101101	-	01000000	@	01010011	S	01100110	f	01110001	y
00101110	.	01000001	A	01010010	T	01100111	g	01110010	z
00101111	/	01000010	B	01010011	U	01101000	h	01110011	{
00110000	0	01000011	C	01010010	V	01101001	i	01110010	
00110001	1	01000010	D	01010011	W	01101010	j	01110011	}
00110010	2	01000011	E	01011000	X	01101011	k	01111010	~

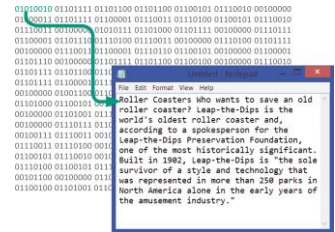
# 1 Representing Text

- ASCII codes are used for numerals, such as Social Security numbers and phone numbers
- Plain, unformatted text is sometimes called ASCII text and is stored in a so-called "text file" with a name ending in .txt
- On Apple devices these files are labeled "Plain Text"; in Windows, these files are labeled "Text Document"

# 1 Representing Text

- ASCII text files contain no formatting
- To create documents with styles and formats, formatting codes have to be embedded in the text

FIGURE 1-4: ASCII TEXT FILES CONTAIN NO FORMATTING CODES

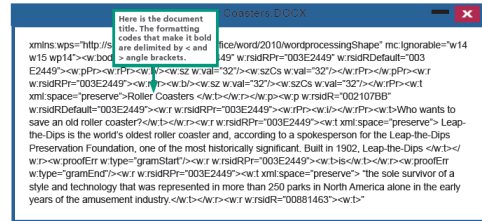


# 1 Representing Text

- Microsoft Word produces formatted text and creates documents in DOCX format
- iWork Pages produces documents in PAGES format
- Adobe Acrobat produces documents in PDF format
- HTML markup language used for Web pages produces documents in HTML format

# 1 Representing Text

FIGURE 1-5: FORMATTING CODES WITHIN A DOCUMENT



## 1 Bits and Bytes

- All of the data stored and transmitted by digital devices is encoded as bits
- Terminology related to bits and bytes is extensively used to describe storage capacity and network access speed
- The word *bit*, an abbreviation for *binary digit*, can be further abbreviated as a lowercase *b*
- A group of eight bits is called a *byte* and is usually abbreviated as an uppercase *B*

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## 1 Bits and Bytes

- When reading about digital devices, you'll frequently encounter references such as 50 kilobits per second, 1.44 megabytes, 2.8 gigahertz, and 2 terabytes.
- Kilo, mega, giga, tera, and similar terms are used to quantify digital data

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## 1 Bits and Bytes

FIGURE 1-6: DIGITAL QUANTITIES

Bit	One binary digit	Gigabit	2 <sup>30</sup> bits
Byte	8 bits	Gigabyte	2 <sup>30</sup> bytes
Kilobit	1,024 or 2 <sup>10</sup> bits	Terabyte	2 <sup>40</sup> bytes
Kilobyte	1,024 or 2 <sup>10</sup> bytes	Petabyte	2 <sup>50</sup> bytes
Megabit	1,048,576 or 2 <sup>20</sup> bits	Exabyte	2 <sup>60</sup> bytes
Megabyte	1,048,576 or 2 <sup>20</sup> bytes		

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## 1 Bits and Bytes

- Use bits for data rates, such as Internet connection speeds, and movie download speeds
- Use bytes for file sizes and storage capacities

FIGURE 1-7: BITS OR BYTES?

**56 Kbps**  
Kilobit (Kb or Kbit) can be used for slow data rates, such as a 56 Kbps (kilobits per second) dial-up connection.

**104 KB**  
Kilobyte (KB or KByte) is often used when referring to the size of small computer files.

**25 Mbps**  
Megabit (Mb or Mbit) is used for faster data rates, such as a 25 Mbps (megabits per second) Internet connection.

**3.2 MB**  
Megabyte (MB or MByte) is typically used when referring to the size of files containing photos and videos.

**100 Gbit**  
Gigabit (Gb or Gbit) is used for really fast network speeds.

**16 GB**  
Gigabyte (GB or GByte) is commonly used to refer to storage capacity.

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## 1 Compression

- To reduce file size and transmission times, digital data can be compressed
- Data compression refers to any technique that recodes the data in a file so that it contains fewer bits
- Compression is commonly referred to as “zipping”

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## 1 Compression

- Compression techniques have two categories: *lossless* and *lossy*
- Lossless compression provides a way to compress data and reconstitute it into its original state; uncompressed data stays exactly the same as the original data
- Lossy compression throws away some of the original data during the compression process; uncompressed data is *not* exactly the same as the original

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# 1 Compression

- Software for compressing data is sometimes referred to as a compression utility or a zip tool
- On laptops and desktop computers, the compression utility is accessed from the same screen used to manage files

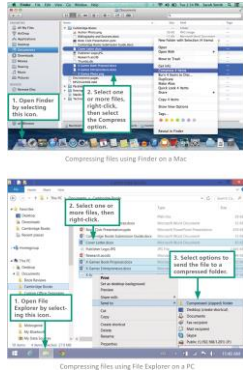


FIGURE 1-8: COMPRESSING FILES

# 1 Compression

- The process of reconstituting files is called extracting or unzipping
- Compressed files may end with a .zip, .gz, .pkg, or .tar.gz

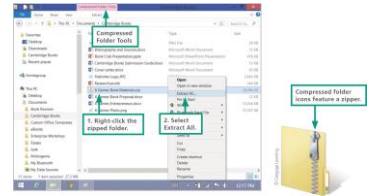


FIGURE 1-9: EXTRACTING FILES IN WINDOWS

# 1 Section B: Digital Sound

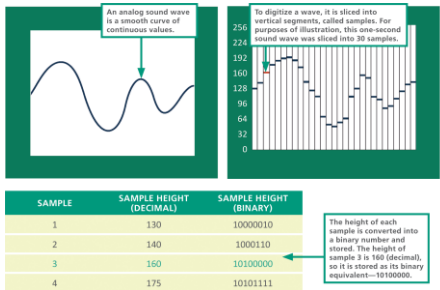
- Digital Audio Basics
- Digital Audio File Formats
- MIDI
- Digitized Speech

# 1 Digital Audio Basics

- Digital audio is music, speech, and other sounds represented in binary format for use in digital devices
- Most digital devices have a built-in microphone and audio software, so recording external sounds is easy
- To digitally record sound samples of a sound wave are collected at periodic intervals and stored as numeric data in an audio file
- Sound waves are sampled many times per second by an analog-to-digital converter
- A digital-to-analog converter transforms the digital bits into analog sound waves

# 1 Digital Audio Basics

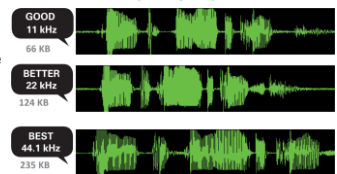
FIGURE 1-10: DIGITIZING A SOUND WAVE



# 1 Digital Audio Basics

- Sampling rate refers to the number of times per second that a sound is measured during the recording process
- Higher sampling rates increase the quality of a sound recording but require more storage space

FIGURE 1-11: SAMPLING RATE, SOUND QUALITY, AND FILE SIZE



# 1 Digital Audio File Formats

- > A digital file can be identified by its type or its file extension, such as Thriller.mp3 (an audio file)
- > The most popular digital audio formats are: AAC, MP3, Ogg, Vorbis, WAV, and WMA

FIGURE 1-12: POPULAR AUDIO FILE FORMATS

AUDIO FORMAT	FILE EXTENSION	ADVANTAGES	DISADVANTAGES
AAC (Advanced Audio Coding)	.aac, .m4p, or .m4a	Very good sound quality based on MPEG-4 compressed format; used for iTunes music	Files can be copy protected so that use is limited to approved devices
MP3 (also called MPEG-1 Layer 3)	.mp3	Good sound quality even though the file is compressed; can be streamed over the Web	Might require a standalone player or browser plugin
Ogg Vorbis	.ogg	Free, open standard; compressed; supported by some browsers	Slow to catch on as a popular standard; part of Google's WebM format
WAV	.wav	Good sound quality; supported in browsers without a plugin	Audio data is stored in raw, noncompressed format, so files are very large
WMA (Windows Media Audio)	.wma	Compressed format; very good sound quality; used on several music download sites	Files can be copy protected; requires Windows Media Player 9 or above

# 1 Digital Audio File Formats

- > To play a digital audio file, you must use some type of audio software, such as:
  - > **Audio Software:** General-purpose software and apps used for recording, playing, and modifying audio files, such as iTunes
  - > **Audio Players:** Small standalone software application or mobile app that offers tools for listening to digital audio and managing playlists, typically included with your computer's OS (operating system)
  - > **Audio Plugins:** Software that works in conjunction with your computer's browser to manage and play audio from a Web page

# 1 Digital Audio File Formats

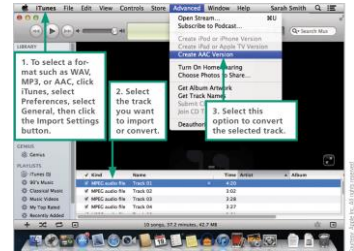
FIGURE 1-13: THREE WAYS TO ACQUIRE DIGITAL MEDIA



# 1 Digital Audio File Formats

- > **Ripping** is a slang term that refers to the process of importing tracks from a CD or DVD to your computer's hard disk
- > The technical term for ripping music tracks is digital audio extraction

FIGURE 1-14: CONVERT AUDIO FILES INTO OTHER FORMATS



# 1 MIDI

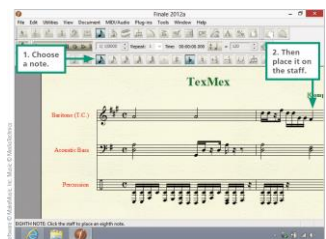
- > MIDI (Musical Instrument Digital Interface) specifies a standard way to store music data for synthesizers, electronic MIDI instruments, and computers
- > MIDI messages are instructions that specify the pitch of a note, the point at which the note begins, the volume of the note, etc.
- > An MIDI message may look like this:



# 1 MIDI

- > Music composition software with MIDI support makes it easy to place notes on a screen-based music staff then play back the composition on a MIDI keyboard or through the speakers of a digital device

FIGURE 1-15: MIDI MUSIC COMPOSITION



## 1 Digitized Speech

- Speech synthesis is the process by which machines produce sound that resembles spoken words
- Speech recognition (or voice recognition) refers to the ability of a machine to understand spoken words

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## 1 Digitized Speech

- Speech recognition software analyzes the sounds of your voice and converts each word into groups of phonemes (basic sound units)
- The software then compares the groups to the words in a digital dictionary to find a match
- When a match is found, the software can display the word on the screen or use it to carry out a command

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## 1 Digitized Speech

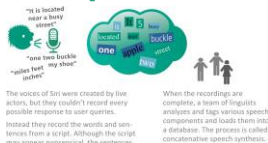


FIGURE 1-17: HOW SIRI WORKS



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## 1 Section C: Bitmap Graphics

- Bitmap Basics
- Bitmap Data Representation
- Bitmap Resolution
- Image Compression
- Modifying Bitmap Images

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## 1 Bitmap Basics

- As digital devices gained the ability to display images, two types of computer graphics evolved: bitmap & vector
- A bitmap graphic is composed of a grid of tiny rectangular cells
- Each cell is a picture element, commonly called a pixel
- Each pixel is assigned a color, which is stored as a binary number

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## 1 Bitmap Basics

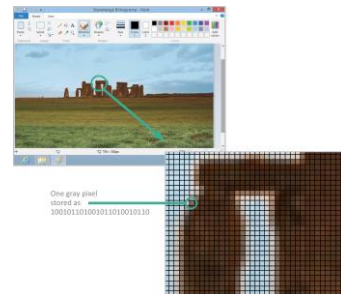


FIGURE 1-18: BITMAP GRAPHICS ARE PIXEL BASED

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## 1 Bitmap Basics

- You can create a bitmap graphic from scratch using the tools provided by graphics software – specifically a category of graphics software referred to as paint software
- Examples of paint software are, Adobe photoshop, iPhoto, and Microsoft Paint

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## 1 Bitmap Basics

- You can use a scanner to convert a printed image into a bitmap graphic
- A scanner divides an image into a fine grid of cells and assigns a digital value for the color of each cell
- As a scan progresses the values are transferred to a digital device and stored as a bitmap graphics file

To scan an image, turn on the scanner and start your scanner software. Place the image face down on the scanner glass, then use the scanner software to initiate the scan. The scanned image is saved in memory and can then be saved on your computer's hard disk or in another storage location.



FIGURE 1-19: SCAN IMAGES

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## 1 Bitmap Basics

- In a digital camera, the lens focuses light from the image onto a small image sensor called a CCD (charge-coupled device)
- A CCD contains a grid of tiny light sensitive diodes called photosites
- Photosites correspond to pixels; the more pixels used to capture an image, the higher its resolution
- Cameras, scanners, and graphics software offer a choice of bitmap formats, such as BMP, RAW, TIFF, JPEG, GIF, and PNG

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## 1 Bitmap Data Representation

- Color and resolution are key elements in bitmap data representation
- Today's color display devices represent color using the RGB color model

Look at the center where the circles intersect to see the color that is generated. Color numbers are shown in decimal, hexadecimal, and binary.

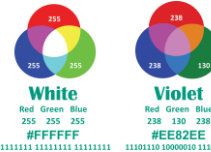


FIGURE 1-22: RGB COLOR

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## 1 Bitmap Data Representation

- Color values can be specified in decimal (base 10), hexadecimal (base 16), or binary (base 2)
- With eight bits used to represent each color value, one pixel requires 24 bits
- The number of colors available in a graphic is referred to as color depth

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## 1 Bitmap Resolution

- The dimensions of the grid that forms a bitmap graphic are referred to as image resolution
- High-resolution graphics contain more data than low-resolution graphics; more data makes it possible to display and print high-quality images that are sharper and clearer

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## 1 Bitmap Resolution

- Graphics software, such as Adobe Photoshop, can help you gauge how large an image can be printed before the quality begins deteriorate

FIGURE 1-24: IMAGE SIZE



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## 1 Image Compression

- Image compression refers to any technique that recodes the data in an image file so that it contains fewer bits
- Run-length encoding (RLE) is a type of lossless compression that replaces a series of similarly colored pixels with a binary code that indicates the number of pixels and their colors

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## 1 Image Compression

- Lossy compression techniques discard some data from an image to shrink its file size
- For many images, lossy compression results in only a minor reduction in the sharpness of the images

FIGURE 1-27: COMPRESSED IMAGE QUALITY



Non-compressed JPEG image

JPEG image with 35% compression

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## 1 Modifying Bitmap Images

- Photoshop software and a host of local and online apps make it easy to modify digital images
- Photoediting software includes sophisticated tools based on graphics algorithms that produce amazing transformations of digital images

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## 1 Modifying Bitmap Images

- Characteristics of bitmap that can be modified:
  - Noise reduction** – “noise” refers to spots, dust, and scratches left on old photos after they are scanned
  - Image enhancement** – improves brightness, color saturation, and focus
  - Selective color change** – algorithms are used to colorize black and white photos
  - Correcting image distortion** – reconstructing perspective with photoediting
  - Cloning** – employs algorithms pulling pixels from one area and moving them to another
  - Inpainting** – reconstructing lost or unwanted areas in a photo
  - Digital compositing** – assembling more than one image into one by using clipping paths and alpha bending

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## 1 Section D: Vector Graphics

- Vector Graphics Basics
- Vector Tools
- 3-D Graphics

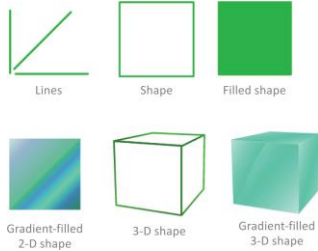
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## 1 Vector Graphics Basics

- The first graphics that appeared on computer screens were not photos, but simple shapes consisting of lines and curves, each referred to as a vector

FIGURE 1-32: VECTOR LINES AND SHAPES



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## 1 Vector Graphics Basics

- A vector graphic consists of a set of instructions for creating a picture
- Vector graphics include standard shapes such as circles and rectangles

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## 1 Vector Graphics Basics

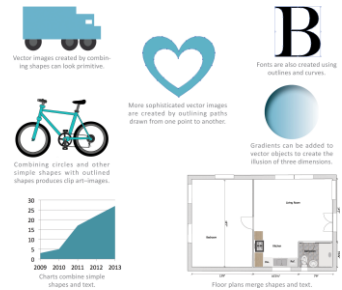
- Vector Graphics vs. Bitmap Graphics
  - Resize better than bitmaps
  - Require less storage space
  - Not as realistic as bitmap images
  - Editing an object is easier than in bitmap

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## 1 Vector Graphics Basics

- Vector graphics are used for line art, logos, simple illustrations, infographic elements, and diagrams



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## 1 Vector Tools

- Vector graphics are created from scratch using drawing software such as:
  - Adobe Illustrator
  - LibreOffice Draw
  - Open source Inkscape
  - Various vector drawing apps

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## 1 3-D Graphics

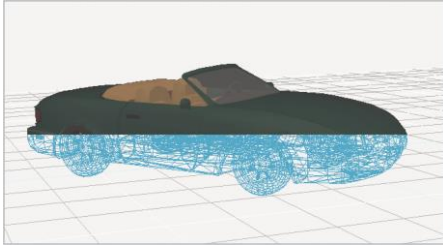
- 3-D Graphics are based on vectors stored as a set of instructions describing the coordinates for lines and shapes in a three-dimensional space
- Vectors form a wireframe that works like the framework for a tent
- The process of covering the wireframe surface with color and texture is called rendering
- The technique for adding light and shadows to a 3-D image is called ray tracing

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## 1 3-D Graphics

FIGURE 1-39: 3-D WIREFRAME PARTIALLY RENDERED INTO AN IMAGE



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## 1 3-D Graphics

- 3-D graphics can be animated to produce special effects for movies or to create interactive, animated characters and environments for 3-D computer games
- An enormous amount of processing power is needed to create 3-D computer animation
- The classic computer game Doom presented in 24-bit color requires 34,560,000 bits for each frame of animation

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## 1 Section E: Digital Video

- Digital Video Basics
- Video Compression
- Video File Formats

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## 1 Digital Video Basics

- Digital video uses bits to store color and brightness data for each video frame, a process similar to storing the data for a series of bitmap images in which the color of each pixel is represented by a binary number
- Footage from home movies, VHS tapes, and other older sources can be digitized using video capture equipment
- You can shoot footage for digital video with:
  - A consumer-quality camcorder
  - A Webcam
  - A Cell phone camera

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## 1 Digital Video Basics

- Digital cinematography is used in the motion picture industry; it captures moving images as bits, rather than on film
- Digital video is a core technology for digital television, videoconferencing systems, and video messaging.

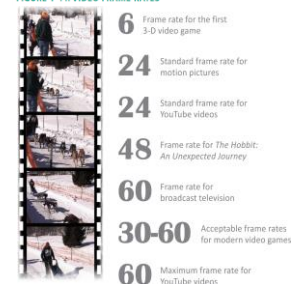
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## 1 Digital Video Basics

- Digital video displays bitmap images in rapid succession
- Each bitmap image is referred to as a frame
- The number of frames that are displayed per second is the frame rate (fps)

FIGURE 1-44: VIDEO FRAME RATES



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# 1 Digital Video Basics

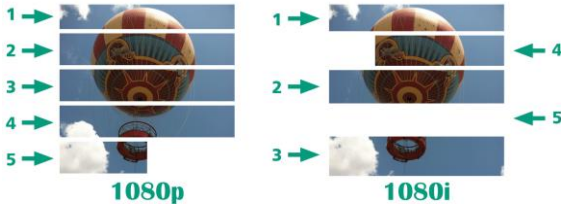
- Video resolutions can be expressed as width x height, as the horizontal resolution, or as the vertical resolution
- Cameras used for digital cinematography capture video with a resolution of 2040 x 1536
- This resolution is referred to as 2K because the horizontal resolution is about 2,000 pixels

# 1 Digital Video Basics

- Vertical resolutions are expressed with a “p” for progressive scan, in which the frame is drawn line by line in sequence from top to bottom
- An interlaced scan is a contrasting scanning technique that produces an image by drawing every other line, then going back and filling in the in-between lines
- Digital video for computers typically uses progressive scanning; digital television uses interlaced scanning

# 1 Digital Video Basics

FIGURE 1-45: PROGRESSIVE OR INTERLACED?



# 1 Digital Video Basics

- Aspect ratio is the proportional relation between the width and height of an image or video frame
- iPads use a 4:3 aspect ratio
- Widescreen devices, such as Laptops and Smartphones, use a 16:9 aspect ratio

# 1 Digital Video Basics

- When 4:3 videos are displayed on a widescreen player, they are bordered by the black bars of a letterbox

FIGURE 1-46: LETTERBOXES

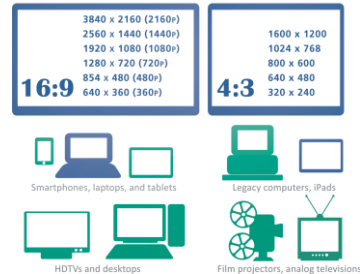
The video on the left has a 16:9 aspect ratio that fits into the YouTube player window. The video on the right has a 4:3 aspect ratio. A letterbox creates black bars to fill the playback window.

Letterbox



# 1 Digital Video Basics

FIGURE 1-47: ASPECT RATIOS FOR POPULAR DEVICES



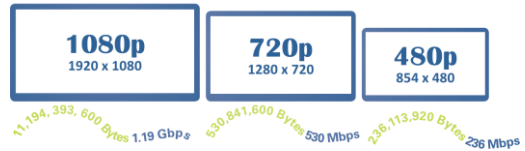
# 1 Digital Video Basics

- 1,194,393,600 bits are needed for one second of digital video
- A feature-length video requires an astounding 8,599,633,920,000 bits! More than one trillion bytes!
- A Bit rate is the number of bits that are processed during a specific unit of time, usually during one second
- Bit rate can be expressed as bits per second (b/sec or bps) & kilobits per second (Kbit/s or Kbps)

# 1 Video Compression

- Choosing a lower resolution when saving a video reduces the bit rate

FIGURE 1-48: LOW RESOLUTION = LOW BIT RATES



# 1 Video Compression

- Compression removes some of the data (bits) through the following techniques:
- Compressor/decompressor software
  - **Image compression** – frames of a video are compressed using lossy and lossless compression
  - **Interframe compression** – stores only the pixels that change color from one frame to the next

# 1 Video Compression

- A codec (compressor/decompressor) is the software that compresses a video stream when a video is stored, and decompresses the file when the video is played
- Each codec uses a unique algorithm to shrink the size of a video file, so they are not interchangeable
- Popular codecs include: MPEG, VP8, DivX, H.264, Theora, and Windows Media Video

# 1 Video File Formats

- Video files are stored in container formats that hold the compressed video stream and an audio stream
- MP4, AVI, MOV, MPEG, WebM, ASF, VOB, and Ogg Theora are popular container formats

# 1 Video File Formats

FIGURE 1-51: VIDEO CONTAINER FORMATS

FORMAT	EXTENSION	PLATFORM	DESCRIPTION AND USE
MPEG (Moving Picture Experts Group)	.mpg, .mp4, .mpeg	PC, Mac, UNIX, Linux	Versions include MPEG-1, MPEG-2, and MPEG-4; used for downloaded and streaming Web video
WebM	.webm	PC, Mac, UNIX, Linux	Royalty-free, high-quality open format for use with HTML5
AVI (Audio Video Interleave)	.avi	PC	A format sometimes used for storing digital clips from video cameras; used for legacy video on the PC platform
MOV (QuickTime Movie)	.mov	PC, Mac, UNIX, Linux	A legacy format for downloaded and streaming Web videos
ASF (Advanced Systems Format)	.asf, .wmv	PC	Container format for Microsoft's Windows Media Video (WMV); supports downloads and streaming
VOB (Video Object)	.vob	Standalone DVD player, PC, Mac, Linux	Industry-standard format for standalone DVD players
Ogg Theora	.ogg	PC, Mac	A non-proprietary container (Ogg) and video codec (Theora)

## 1 Video File Formats

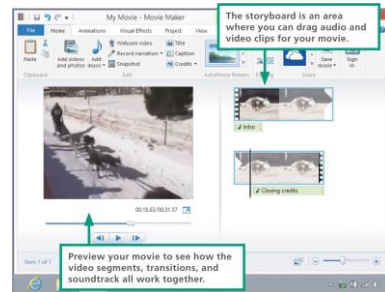
- Browsers support several video formats and Web developers sometimes have to provide a video in multiple formats
- Digital videos can be converted from one format to another through a process called transcoding
- Basic video editing tools are used to arrange video clips, add a soundtrack, insert captions and choose output format

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## 1 Video File Formats

FIGURE 1-52: CREATE A VIDEO



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NEW PERSPECTIVES

## Unit 1 Complete

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