Digital Representation

Chapter 8, Chapter 11

Opening Files

- How does the operating system (OS) know to open up PowerPoint when you double-click the following icon?

- The actual name of the file is `2-Terminology.ppt`
- **file extension**: suffix to the name of a computer file to indicate the format of the file's contents
  - In the example above, `.ppt` is the file extension.

Why Does It Not Show?

- File extensions are normally hidden, but it is best to reveal them so you know the exact file name.
  - Is the following file called `picture.jpg`, `picture.JPG`, `picture.jpeg` or perhaps something else?

- Mac:
  - http://www.fileinfo.net/help/mac-show-extensions.html
- Windows:
  - http://www.fileinfo.net/help/windows-show-extensions.html

A Name Is A Name Is A Name

- What happens if you change the file extension and then try to open the file?
- The OS will open the file with the program associated with the new file extension.
- The program will interpret the file's contents like it does all other files with that same file extension.
- The contents of the file do NOT change.

What Is In A File?

- A file is a sequence of bytes.
  - In modern systems, a byte is generally made up of 8 bits.
- **bit**: unit of information storage, taking a value of either 0 or 1; short for binary digit
  - Compare to a decimal digit that can take a value of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
- Data on a computer is just a series of 1's and 0's.

What Do Bits Mean?

- Whatever you want them to mean!
  - But we have to agree on their meaning so we can communicate with each other.
- Suppose Alice and Bob can only communicate in single bits.
  - Bob thinks that 0 means "You are funny" and 1 means "You stink."
  - Alice thinks that 0 means "You stink" and 1 means "You are funny."
  - Bob tells Alice: 0. Is Bob getting a second date?

How Many Bits Do You Need?

- Single bits cannot store much information. What can we do?
  - Solution: Group bits together!
- How much information can you store with 2 bits?
  - Up to four different pieces of information.

Bit #1	Bit #2	Possible Encoding
0	0	"You are funny"
0	1	"You stink"
1	0	"I am awesome"
1	1	"You are a giraffe"

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How About More Bits?

- How much information can you store with 3 bits?
  - Eight.

Bit #1	Bit #2	Bit #3	Possible Encoding
0	0	0	"You are funny"
0	0	1	"You stink"
0	1	0	"I am awesome"
0	1	1	"You are a giraffe"
1	0	0	"You are a whale"
1	0	1	"I like pie"
1	1	0	"I eat donuts"
1	1	1	"Igloo"

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How Many Encodings With X Bits?

- What is the pattern?
- Each new bit doubles the number of encodings

Number of Bits	Number of Encodings
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256

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ASCII

- **ASCII**: character-encoding scheme based on the English alphabet; acronym for **A**merican **S**tandard **C**ode for **I**nformation **I**nterchange
  - Pronunciation: AS·key

Dec	Char	Dec	Char	Dec	Char	Dec	Char	Dec	Char	Dec	Char	Dec	Char	Dec	Char
0	Null	16	Data link escape	32	Space	48	0	64	@	80	P	96	`	112	p
1	Start of heading	17	Device control 1	33	!	49	1	65	A	81	Q	97	a	113	q
2	Start of text	18	Device control 2	34	"	50	2	66	B	82	R	98	b	114	r
3	End of text	19	Device control 3	35	#	51	3	67	C	83	S	99	c	115	s
4	End of transmit	20	Device control 4	36	$	52	4	68	D	84	T	100	d	116	t
5	Enquiry	21	Neg. acknowledge	37	%	53	5	69	E	85	U	101	e	117	u
6	Acknowledge	22	Synchronous idle	38	&	54	6	70	F	86	V	102	f	118	v
7	Audible bell	23	End trans. block	39	'	55	7	71	G	87	W	103	g	119	w
8	Backspace	24	Cancel	40	(	56	8	72	H	88	X	104	h	120	x
9	Horizontal tab	25	End of medium	41	)	57	9	73	I	89	Y	105	i	121	y
10	Line feed	26	Substitution	42	*	58	:	74	J	90	Z	106	j	122	z
11	Vertical tab	27	Escape	43	+	59	;	75	K	91	[	107	k	123	{
12	Form feed	28	File separator	44	,	60	<	76	L	92	\	108	l	124	|
13	Carriage return	29	Group separator	45	-	61	=	77	M	93	]	109	m	125	}
14	Shift out	30	Record separator	46	.	62	>	78	N	94	^	110	n	126	~
15	Shift in	31	Unit separator	47	/	63	?	79	O	95	_	111	o	127	⌂

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Unicode

- Need more than the Roman alphabet.
- As of Unicode 5.1, there are 100,507 graphic characters.

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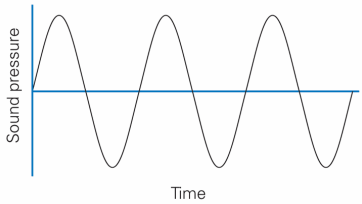
Beyond Text: How To Encode Sound?



- There are an infinite number of values of sound pressure from 1.01 to 1.001 to 1.0001 to etc…
- But with a finite number of bits, you can have only a finite number of encodings.

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Sampling

- **sample**: to take measurements at regular intervals
- **sampling rate**: number of samples per second
- The higher the sampling rate, the more accurately the wave is recorded.

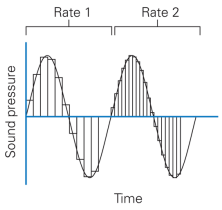


Figure 11.4. Two sampling rates; the rate on the right is twice as fast as that on the left.

Why Not Extremely High Sampling Rates?

- The higher the sampling rate, the more data points that must be recorded resulting in larger file sizes.
- In the extreme case, there are so many data points that playback might not be able to process the data fast enough.

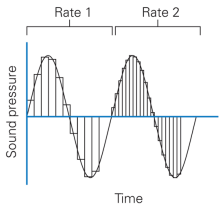
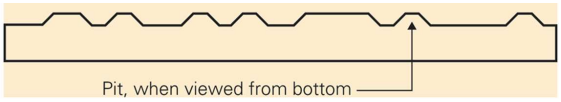


Figure 11.4. Two sampling rates; the rate on the right is twice as fast as that on the left.

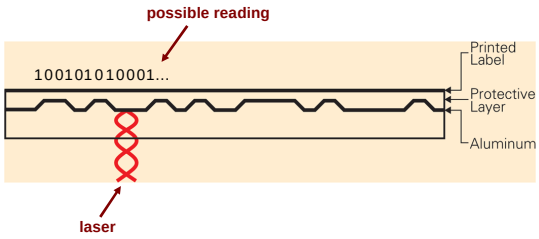
Encoding Bits On A CD

- Close-up of a CD



- Laser reads CD from the bottom.
  - Change in depth represents a "1".
  - No change represents a "0".

Encoding Bits On A CD



Analog To Digital And Back Again

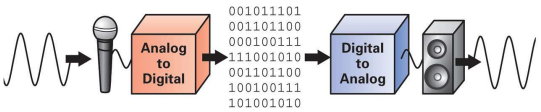


Figure 11.5. Schematic for analog-to-digital and digital-to-analog conversion.

Encoding Images

- Digital cameras sample images into pixels and RGB colors.
- 24-bit RGB color model has 16,777,216 possible colors.
  - 8 bits per color means 256 possible intensities per color
  - Recall that an RGB triplet for a color in CSS is written as: `rgb(R,G,B)` where *R*, *G*, and *B* are each numbers from 0 to 255

256 possible values!