Digital Information

INFO/CSE 100, Autumn 2004 Fluency in Information Technology

http://www.cs.washington.edu/100

cse100-19-more-digital © 2004 University of Washington

Readings and References

- Reading

 Fluency with Information Technology
 Chapter 11, Representing Multimedia Digitally

 Wikipedia The Free Encyclopedia

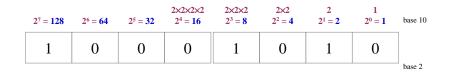
 Arabic numerals, ASCII
 http://en.wikipedia.org/wiki/Arabic_numerals
 http://en.wikipedia.org/wiki/Ascii
 - Cyrillic Text
 - http://www.dimka.com/ru/cyrillic/

19-Nov-2004

cse100-19-more-digital © 2004 University of Washington

2

Recall: What do number positions represent?

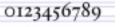


$1 \cdot 128 + 1 \cdot 8 + 1 \cdot 2 = 138_{10}$

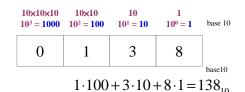
Each position represents one more multiplication by the base value.

For binary numbers, the base value is 2, so each new column represents a multiplication by 2.

Use the base, Luke



- Each position represents one more multiplication by the base value
 - » The base value can be 2 *binary numbers*
 - Two symbols: 0 and 1
 - Each column represents a multiplication by two
 - » The base value can be 10 *decimal numbers*
 - Ten symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
 - Each column represents a multiplication by ten



19-Nov-2004

19-Nov-2004

3

1

Base 16 Hexadecimal

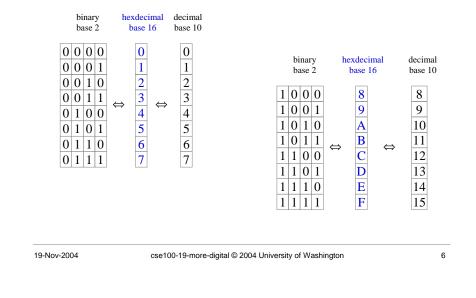
- The base value can be 16 *hexadecimal numbers*
 - » Sixteen symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
 - » Each column represents a multiplication by sixteen
 - » Hex is easier to use than binary because the numbers are shorter even though *they represent the same value*



$8 \cdot 16 + 10 \cdot 1 = 138_{10}$



Four binary bits \Leftrightarrow One hex digit



Binary to Hex examples hase 2 8 2 0 7 Α 1 0 F base 16 $10000010000001111010000100001111_{2} = 8207A10F_{16}$ $10000011010001010110100110111110_{2} = ----$ 19-Nov-2004 cse100-19-more-digital © 2004 University of Washington 7

Whew! We are now official geeks ...



Recall: The hardware is binary

- How many numbers can we represent with 0 and 1?
 - » As many as we want, it just takes a little more space to get a bigger range
- So what can we represent with these numbers?
 - » Anything that has a numeric value or can be associated with a numeric value
 - » Number of people, index into a list, account balance, ...
 - » Alphabetic characters, punctuation marks, display tags
 - » Any signal that can be converted into numeric values
 - colors, sounds, water level, blood pressure, temperature
 - » Computer instructions

19-Nov-2004

cse100-19-more-digital © 2004 University of Washington

Represent numbers

- How many bit positions to allocate?
 - » Depends on the desired range
 - » 8 bits \rightarrow 0 to 255
 - or -128 to +127
 - » 16 bits \rightarrow 0 to 65535
 - or -32768 to +32767
 - » 32 bits \rightarrow 0 to 4294967296
 - or -2B to +2B

cse100-19-more-digital © 2004 University of Washington

10

Represent Text - ASCII

- Assign a unique number to each character
 - » 7-bit ASCII
 - Range is 0 to 127 giving 128 possible values
 - There are 95 printable characters
 - There are 33 control codes like tab and carriage return

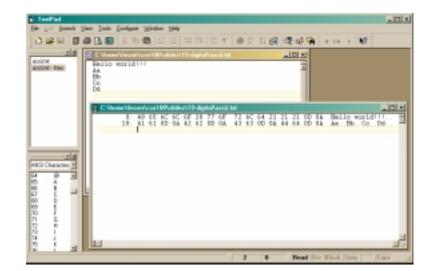


cse100-19-more-digital © 2004 University of Washington

11

9

ASCII text



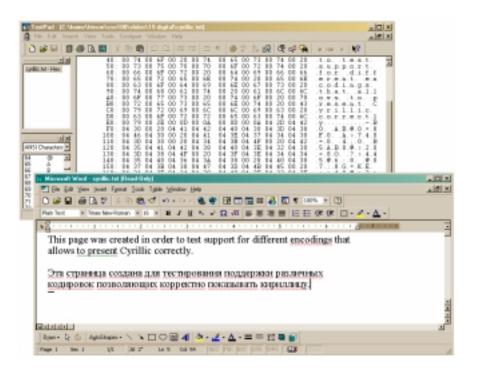
19-Nov-2004

Represent Text - Unicode

- The goal of Unicode is to provide the means to encode the text of every document people want to store in computers
- Unicode aims to provide a unique number for each letter, without regard to typographic variations used by printers
- Unicode encodes each character in a number
 - » the number can be 7, 8, 16, or 32 bits long
 - » 16-bit encoding is common today

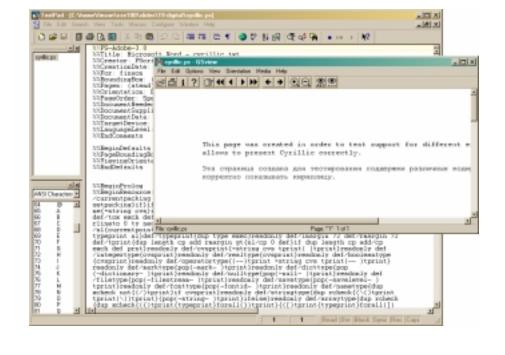
19-Nov-2004	

cse100-19-more-digital © 2004 University of Washington



Represent Text - Postscript

- Postscript is a page description language somewhat like HTML
 - » The file is mostly text and can be looked at with a regular text editor
 - » programs that know what it is can interpret the embedded commands
 - » Programs *and printers* that understand Postscript format can display complex text and graphical images in a standard fashion



15

13

Represent Text - PDF

- PDF is another page description language based on Postscript
- The file is mostly text
 - » can be looked at with a regular text editor
 - » programs that know what it is can interpret the embedded commands
 - » just like Postscript and HTML in that respect

cse100-19-more-digital © 2004 University of Washington

	80 III H + F H + F B		
			12
a.		C spills pill - ModPal	<u>ala</u>
Th		File Edit View Inset Format Help	
14			
		kppp-1_1	
W	This page was created in	18670	
0.	allows to present Cyrill	5.0.003	
24	Sva ovpasska conassa ane	42	
	supported sindowners may		
8		/H (672 660)	
90 14		/1. 17174	
14		/E 16051	
2		/11 1	
A 14 16/1	NUMBER OF THE OWNER AND	/T 16087	
of the second second	and the second s	endob1	
			1808
		3.14	
		0800808014 80080 s	
		08000008424 80080 m	
		0800808837 80080 a 0800808987 80080 a	
		OBODECI13E DODEC a	
		0800801111 80080 m	
		0800001819 00000 x	
		0800803834 80080 x	
		08000117712 80080 a	
		0800018945 80080 m 0800014248 80080 m	
		0800814709 80080 8	
		0800808477 80080 a	
		0800000817 00080 a	
		testler	
		01	
		/8188 37 /2x50 2 0 8	
		/ 3829 E O R (Base # D B	
		Fas Help, press F1	

Represent Color - Bit Map

- Numbers can represent anything we want
- Recall that we can represent colors with three values
 - » Red, Green, Blue brightness values
- There are *numerous* formats for image files
 - » All of them store some sort of numeric representation of the brightness of each color at each pixel of the image
 - » commonly use 0 to 255 range (or 0 to FF_{16})

19-Nov-2004

19

17

	🚺 MarWen HDWen - C. Mane Mean Yane 100 Male	ins/19 digital/billings	_ ICI XI
🌲 hibmp - MonWiew	File		
File Edit Image Dplans View Halp			88 11-
# = = × / % % < (() @ % %		0 00 01 00 10 00 00	# [5
The second se		6 88 20 NE 88 00 00	
	888999996: 28 00 00 28 00 00 C8 C0 F		
		B CB FF EB CB FF EB	
Hit	Researchers of the second seco	BITT COLD ITT COLD	
	BBBBBBBBC CE CO FF CE CO FF CE CO FF BBBBBC78- CE FF CE CE FF CE CE FF C	F CE CO FF CE CO FF B CO FF ED CO FF ED	
	appoone: FF co co FF co co FF co c	a sa ti sa sa ti sa	
	BBBBBBB CB CB FF CB CB FF CB CB F		
108 x 180 x 24 8 4/6 100 % 25.35 68 / 25		B CH FF ED CH FF ED	
		B FF CO CO FF CO CO	77 11
Second 10 32-14 (1924-2011)	REPORTED: OR CO FF OR CO FF OR CO F	F CR CO FF CR CO FF	08 (1
Edit Options Ether Scope	BBBBBBB CEFF CE CE FF CE CEFF C	B CB FF EB CB FF EB	CE (I
For Sheer Car 24	ABBONES: IT CO ES IT CO ES IT CO E	B FF CO CO FF CO CO	17 1
	NANNOFA: CA CO FF CA CO FF CA CO F	F CB CO FF CB CO FF	
	ABBOILDE: CA FF EE CA FF EE CA FF E	B CA FF EB CA FF EB	
	ABBOTTO: FF CO ED FF CO ED FF CO ED FF	BIFF COLD FF COLD	
	BBBB1201 CB CB T CB CB FF CB CB FF BBBB1201 CB CB FF CB CB FF CB CB FF CB	F CB CO FF CB CO FF	
	BBBB1140; F CO CO FF CO CO FF CO C	B FF CO CO FF CO CO	
	assorte: Ca ca FF Ca ca FF Ca ca F	T CA CO FF CA CO FF	
	BRATISE: CH FF CO CH FF CO CH FF C	B CH FF ED CH FF ED	
	ABBOIZE: FY CO CO FF CO CO FF CO C		77 11
	REDOTING: CR CO FF CR CO FF CR CO F	F CH CO FF CH CO FF	C8 (i
	BBBBBBBB CB FF CB CB FF CB CB FF C	B CB FF EB CB FF EB	CB (i
	REBOILE: IT CO ED IT CO ED IT CO E		
	BBBBTER: CE CO FF CE CO FF CE CO F		
		B GA FF EB GA FF EB	
	BBBBBBB: FF CO ED FF CO ED FF CO E		
	BODDIED: CA CO FF CA CO FF CA CO F	F CA CO FF CO CO FF D CA FF ED CA FF ED	
			22
↓ / I	apporte: Oa co FF Oa co FF Oa co F	F OR CO FF OR CO FF	
	BBBBCOD: CB FF CB CB FF CB CB FF C	B CH FF CB CH FF CB	
\$0208.01711 \$PF.00.000 \$		B FF CO CO FF CO CO	

What about "continuous" signals?

- Color and sound are natural quantities that don't come in nice discrete numeric quantities
- But we can "make it so!"



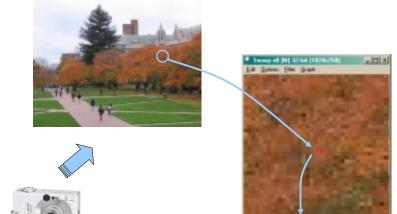


19-Nov-2004

cse100-19-more-digital © 2004 University of Washington

21

Digitized image contains color data



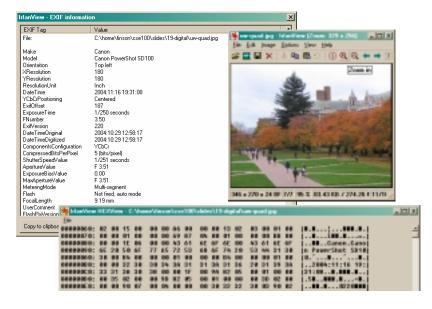


19-Nov-2004

cse100-19-more-digital © 2004 University of Washington

22

And much, much more!



Summary

- Bits can represent any information
 - » Discrete information is directly encoded using binary
 - » Continuous information is made discrete
- We can look at the bits in different ways
 - » The format guides us in how to interpret it
 - » Different interpretations let us work with the data in different ways