Digital Information

INFO/CSE 100, Autumn 2004 Fluency in Information Technology

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

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Readings and References

- Reading

 Fluency with Information Technology
 Chapter 11, Representing Multimedia Digitally

 Wikipedia The Free Encyclopedia

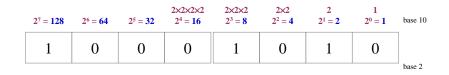
 Arabic numerals, ASCII
 http://en.wikipedia.org/wiki/Arabic_numerals
 http://en.wikipedia.org/wiki/Ascii
 - Cyrillic Text
 - http://www.dimka.com/ru/cyrillic/

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Recall: What do number positions represent?

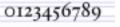


$1 \cdot 128 + 1 \cdot 8 + 1 \cdot 2 = 138_{10}$

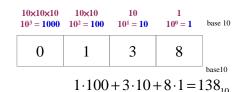
Each position represents one more multiplication by the base value.

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



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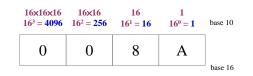
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Base 16 Hexadecimal

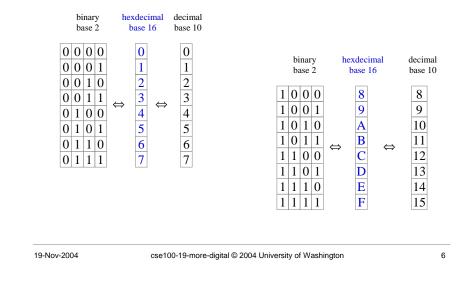
- The base value can be 16 *hexadecimal numbers*
 - » Sixteen symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
 - » Each column represents a multiplication by sixteen
 - » Hex is easier to use than binary because the numbers are shorter even though *they represent the same value*



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



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

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Represent numbers

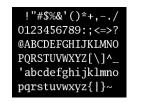
- How many bit positions to allocate?
 - » Depends on the desired range
 - » 8 bits \rightarrow 0 to 255
 - or -128 to +127
 - » 16 bits \rightarrow 0 to 65535
 - or -32768 to +32767
 - » 32 bits \rightarrow 0 to 4294967296
 - or -2B to +2B

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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

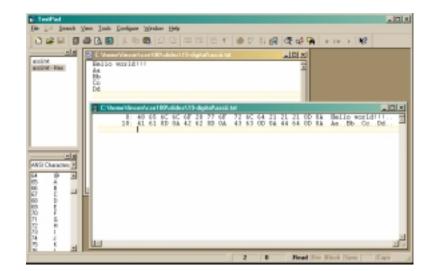


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ASCII text



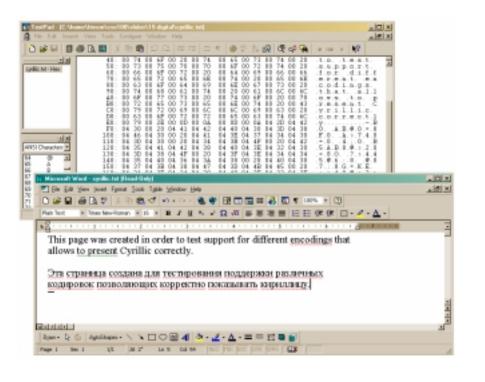
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Represent Text - Unicode

- 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

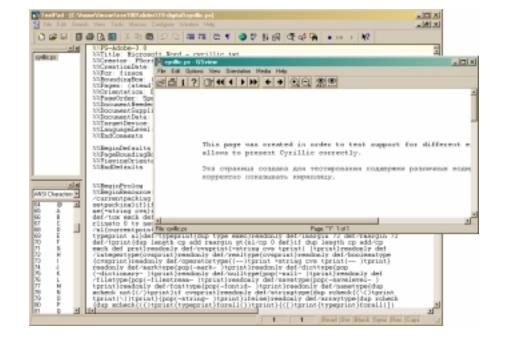
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Represent Text - Postscript

- 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



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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

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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})

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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!"



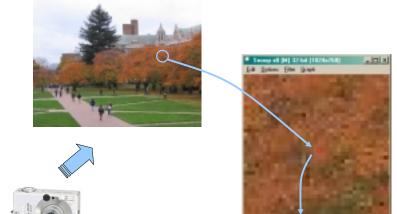


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Digitized image contains color data



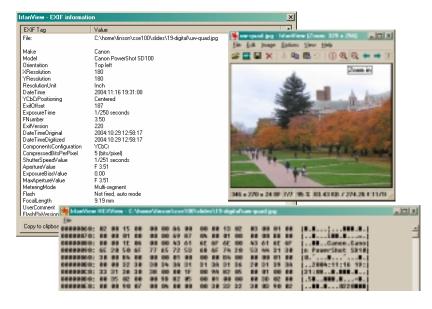


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And much, much more!



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