



Digital Representation

Everyone knows computers use bits and bytes ... but what are they?

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Info Representation

Digitization: representing information by any fixed set of symbols

1	ABC	DEF
2		
3		
4	GHI	JKL
5		
6		
7	MNO	PQR
8		
9		
*	STU	VWX
0		
#		

The representation associates one item with each symbol ... encode the telephone keypad using ten colors



What number is: [grid of 10 colored squares] ?

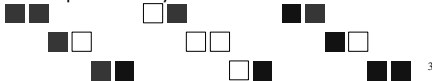
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Creating Symbols

Often, there are many things to digitize, but too few symbols available

- * The solution is to create more symbols by composing patterns ...
- * Three patterns make three symbols: [three 2x2 grids of black and white squares]
- * Pairing them makes 9 symbols; when they are triples, 27 symbols, and ...



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An Encoding

Encode the Latin alphabet

Three pattern [] [] [] triples = 27 symbols

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]
[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]	[]



Digitize -- encode with symbols

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Info in the Physical World

Physical world:

- * The most fundamental representation of information is presence/absence of a phenomenon
 - matter, light, magnetism, flow, charge, ...
- * detect: "Is the phenomenon present?"
- * set: make phenomenon present or absent

The PandA representation

Any controllable phenomenon works: define it right



Info in the Logical World

Logical World:

- * Information, reasoning, computation are formulated by true/false and logic
 - All men are mortal
 - Aristotle is a man
 - Aristotle is mortal

True and false can be the patterns for encoding information

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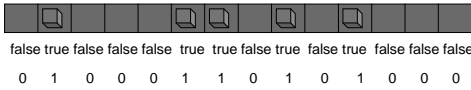
Connect Physical/Logical

The miracle of IT is that physical and logical worlds can be connected

Present represents true / Absent represents false

-- or maybe vice versa, if everyone agrees--

Pavement Memory



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Bits

Panda is a *binary representation* because it uses 2 patterns

Bit -- it's a contraction for "binary digit"

-- a position in space/time capable of being set and detected in 2 patterns

Sherlock Holmes's *Mystery of Silver Blaze* -- a popular example where "absent" gives information ... the dog didn't bark, that is the phenomenon wasn't detected

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Bytes

A byte is eight bits treated as a unit

- * Adopted by IBM in 1960s
- * A standard measure ever since
- * Bytes encode the Latin alphabet using ASCII -- the American Standard Code for Information Interchange

0100 0110
0100 1001
0101 0100

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ASCII

ASCII	0	1	2	3	4	5	6	7	8	9	:	.	<	=	>	?
0000	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
0001	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
0010	!	"	#	\$	%	&	'	()	*	+	,	-	.	/	
0011	0	1	2	3	4	5	6	7	8	9	:	.	<	=	>	?
0100	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
0101	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	_
0110	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
0111	p	q	r	s	t	u	v	w	x	y	z	{		}	~	?
1000	%	"	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1001	%	"	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1010	%	j	%	E	n	%	i	%	%	%	%	%	%	%	%	%
1011	%	A	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1100	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
1101	B	N	O	O	O	O	O	O	O	O	O	O	O	O	O	O

0100 0110
0100 1001
0101 0100

0100 1000 0111 0101 0111 0011 0110 1011 0110 1001 0110 0101 0111 0011 0010 0001

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Demonstration

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Encoding Information

Bits and bytes encode the information, but that's not all

- * Tags encode format and some structure in word processors
- * Tags encode format and some structure in HTML
- * In the *Oxford English Dictionary* tags encode structure and some formatting

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OED Entry For Byte

byte (bait). *Computers.* [Arbitrary, prob. influenced by *bit* *sb.*⁴ and *bit* *sb.*] A group of eight consecutive bits operated on as a unit in a computer. **1964** *Blaauw & Brooks* in *IBM Systems Jnl.* III. 122 An 8-bit unit of information is fundamental to most of the formats [of the System/360]. A consecutive group of *n* such units constitutes a field of length *n*. Fixed-length fields of length one, two, four, and eight are termed bytes, halfwords, words, and double words respectively. **1964** *IBM Jnl. Res. & Developm.* VIII. 97/1 When a byte of data appears from an I/O device, the CPU is seized, dumped, used and restored. **1967** *P. A. Stark Digital Computer Programming* xix. 351 The normal operations in fixed point are done on four bytes at a time. **1968** *Dataweek* 24 Jan. 1/1 Tape reading and writing is at from 34,160 to 192,000 bytes per second.

<e>chg</hw> byte</hw> <pr><ph>bait</ph></pr></hg> <la>Computers</la> <etym>Arbitrary, prob. influenced by <xr><x>bit</x></xr> <ps>n.<hm>4</hm></ps>and <xr><x>bite</x></ps>n.</ps> </xr></etym> <s4>A group of eight consecutive bits operated on as a unit in a computer.</s4> <qt><q><qd>1964</qd>Blaauw & Brook <blb>ine</bib></w>IBM Systems Jnl.</w> <lc>III. 122</lc></qt>An 8-bit unit of information is fundamental to most of the formats <ed>of the System/360</ed>.&es.A consecutive group of n such units constitutes a field of length <n</n>.&es.Fixed-length fields of length one, two, four, and eight are termed bytes, halfwords, words, and double words respectively.</qt></q><q><qd>1964</qd> <w>IBM Jnl. Res. & Developm.</w> <lc>VIII. 97/1</lc>When a byte of data appears from an I/O device, the CPU is seized, dumped, used and restored.</qt></q><q><qd>1967</qd> <a>P. A. Stark <w>Digital Computer Programming</w> <lc>xix. 351</lc></qt>The normal operations in fixed point are done on four bytes at a time.</qt></q><q><qd>1968</qd> <w>Dataweek</w> <lc>24 Jan. 1/1</lc> 13</qt>Tape reading and writing is at from 34,160 to 192,000 bytes per second.</qt>



Summary

IT joins physical & logical domains so physical devices do our logical work

- * Symbols represent things 1-to-1
- * Create symbols by grouping patterns
- * PandA representation is fundamental
- * Bit, a place where 2 patterns set/detect
- * ASCII is a byte encoding of Latin α bet
- * In addition to content, encode structure

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