Codes

Codes

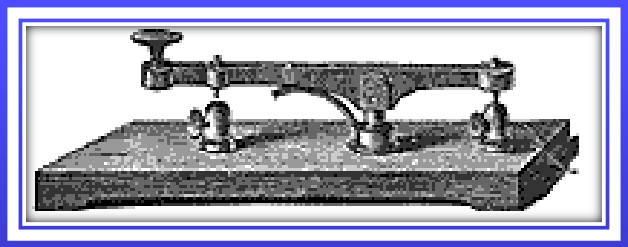
- Codes are groupings of symbols that are used for information exchange…

Examples ?

Example: Morse code (1844)

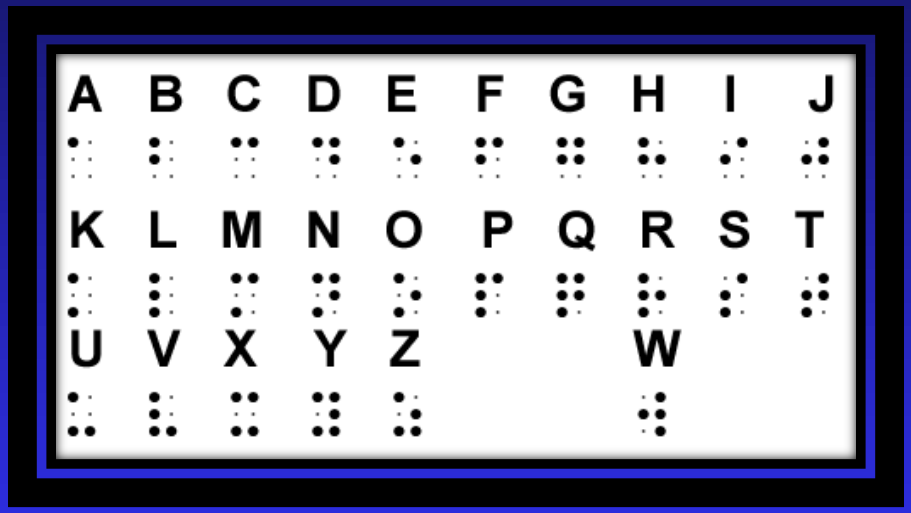
Morse code key

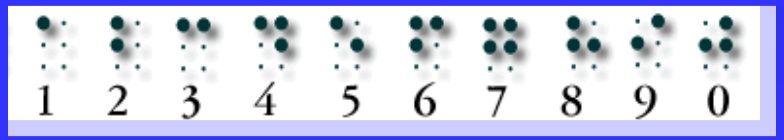
Letters		Numbers	
A	•—	1	•—————
B	—•••	2	••———
C	—•—•	3	•••——
D	—••	4	••••—
E	•	5	•••••
F	••—•	6	—••••
G	——•	7	——•••
H	••••	8	———••
I	••	9	————•
J	•———	0	—————
K	—•—		
L	•—••		
M	——		
N	—•		
O	———		
P	•——•		
Q	——•—		
R	•—•		
S	•••		
T	—		
U	••—		
V	•••—		
W	•——		
X	—••—		
Y	—•——		
Z	——••		



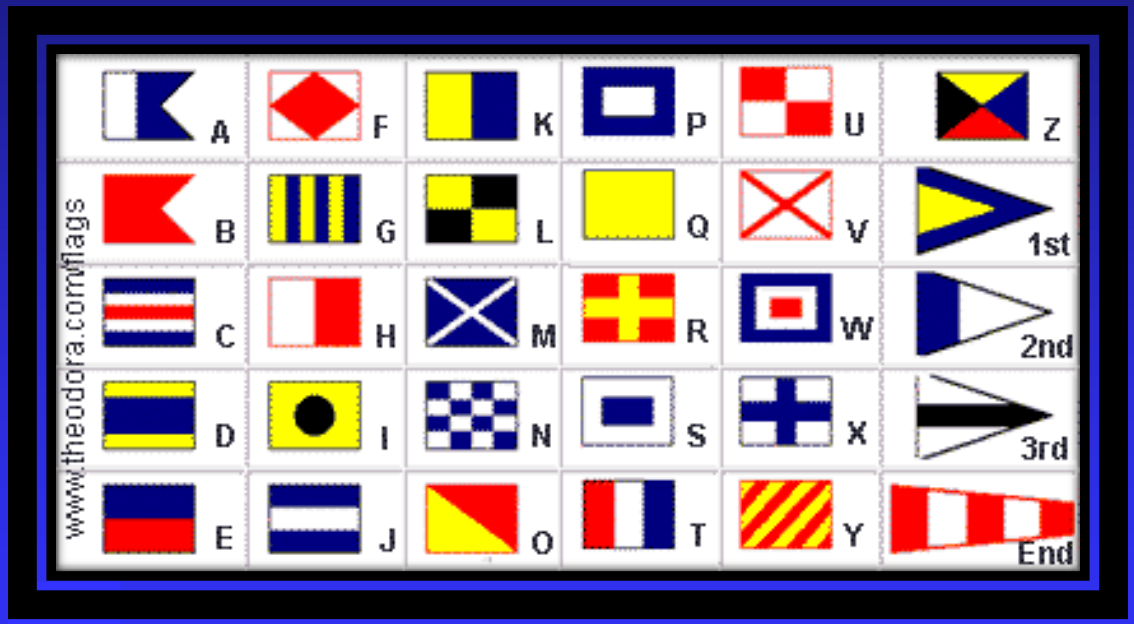
Used in telegraphy … today is a historical code

Example: Braille code

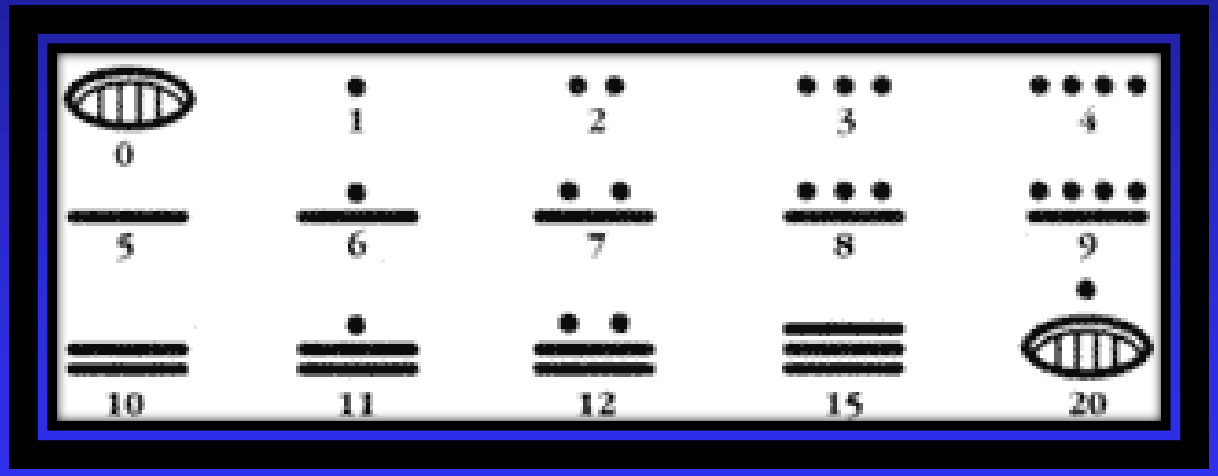




Example: Nautical flag code



Example: Maya code-numbers



Example: Maya code (?)

Binary Codes

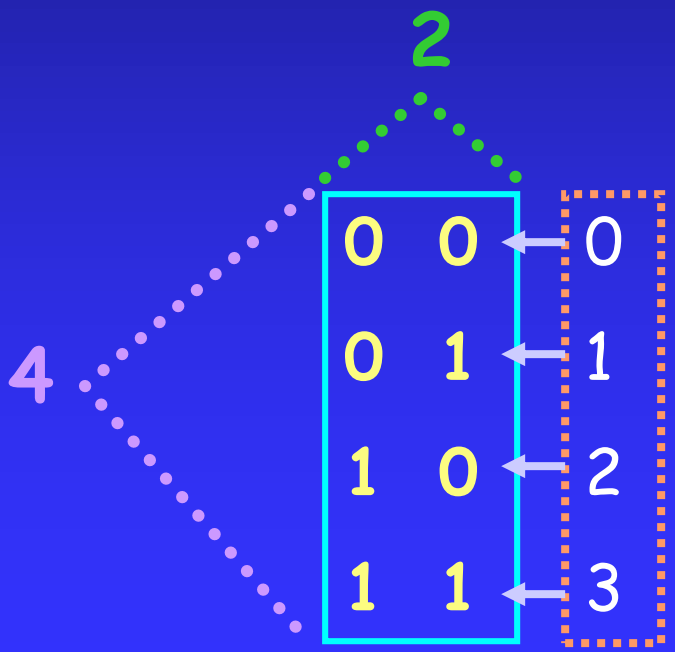
- To represent a group of 2^n distinct elements in a binary code, it requires a minimum of **n**-bits.

Example-1

- It is known that a digital computer uses two states that are represented with: the zero and the one.

Example-1

- It is known that a digital computer uses two states that are represented with: the zero and the one.
- A group of four different binary elements can be represented with 2 bits.



Example-2

- A group of eight distinct elements can be represented by 3 bits.

0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Special Codes

Special Codes

- 8-4-2-1
- BCD
- Excess-3
- Aiken
- 2-out-of-5

Binary (8-4-2-1)

	8421
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

Weighted Code

Binary Coded Decimal (BCD)

	BCD
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
	1010
	1011
	1100
	1101
	1110
	1111

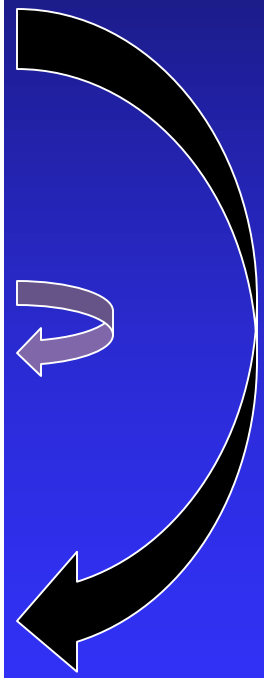
not used

Excess-3 (XS3)

	XS3
	0000
	0001
	0010
0	0011
1	0100
2	0101
3	0110
4	0111
5	1000
6	1001
7	1010
8	1011
9	1100
	1101
	1110
	1111

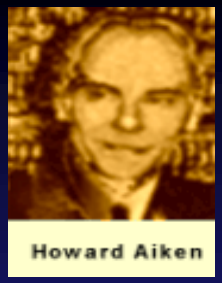
Excess-3 (XS3)

	XS3
	0000
	0001
	0010
0	0011
1	0100
2	0101
3	0110
4	0111
5	1000
6	1001
7	1010
8	1011
9	1100
	1101
	1110
	1111



Symmetric code

Aiken code



	Aiken
0	0000
1	0001
2	0010
3	0011
4	0100
	0101
	0110
	0111
	1000
	1001
	1010
5	1011
6	1100
7	1101
8	1110
9	1111

2-4-2-1 Code …

Aiken code

	Aiken
0	0000
1	0001
2	0010
3	0011
4	0100
	0101
	0110
	0111
	1000
	1001
	1010
5	1011
6	1100
7	1101
8	1110
9	1111

Symmetric code

2-4-2-1 Code …

2-out-of-5

	2-out-of-5
0	11000
1	00011
2	00101
3	00110
4	01001
5	01010
6	01100
7	10001
8	10010
9	10100

Very Practical Code …

It is used as Error Detecting Code;
… natural even parity

2-out-of-5

	2-out-of-5
0	11000
1	00011
2	00101
3	00110
4	01001
5	01010
6	01100
7	10001
8	10010
9	10100

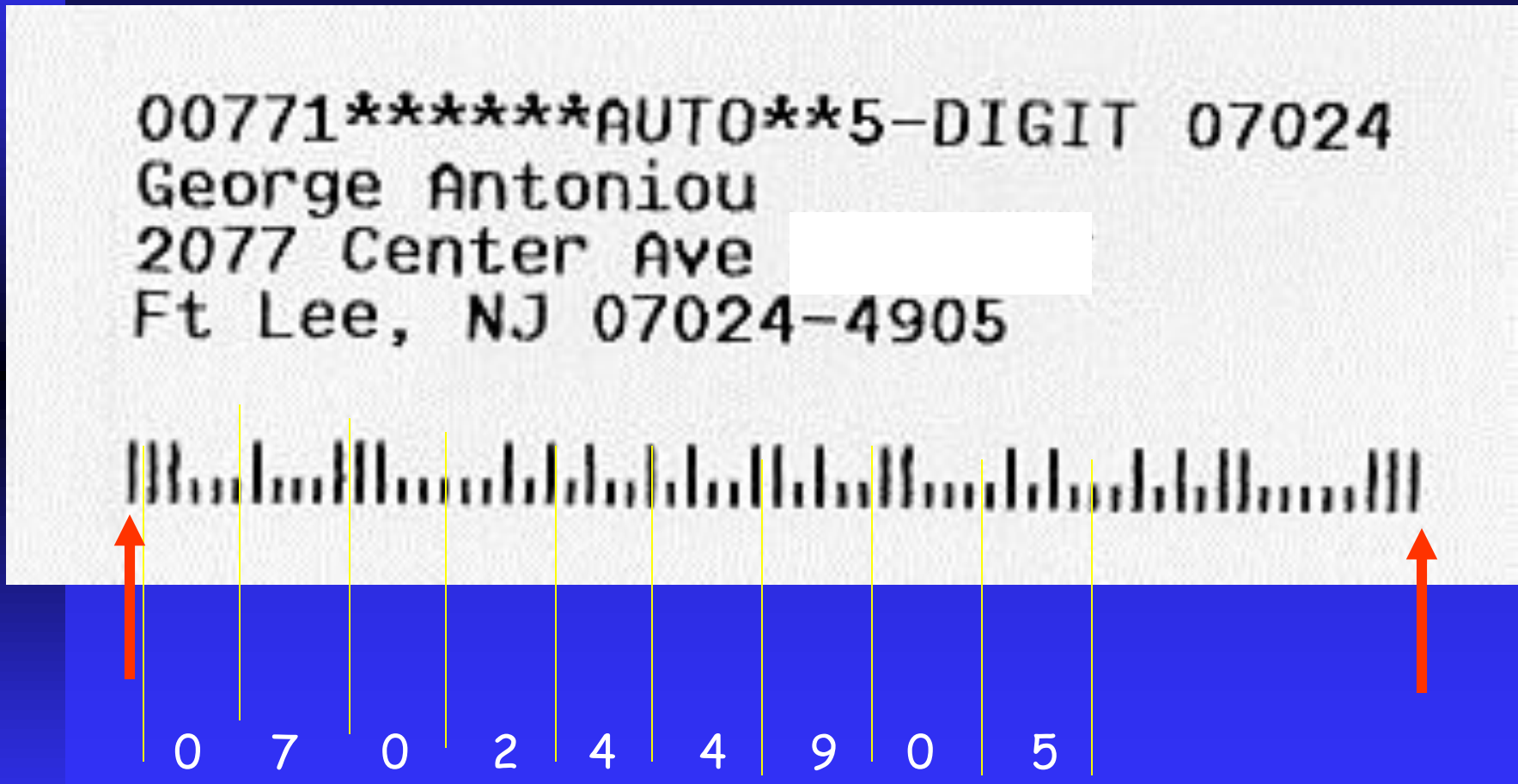
Except for the zero (0) which is decimal 24. The rest of the code follows the weights: 74210

2-out-of-5

This code is used by the
U.S. Postal Service
---- Zip Code

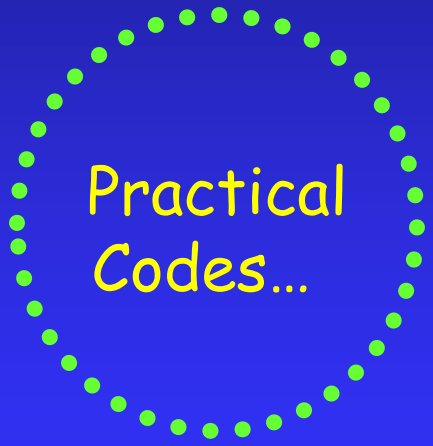
The first and last bars are the frame bars, used for aligning the scanner which reads the bar-code. The last digits are used for error correction (checksum).....

The first and last bars are the frame bars, used for aligning the scanner which reads the bar-code. The last digits are used for error correction (checksum).....



Bar Code based codes

- 1-D codes
- 2-D codes



1-D and 2-D Codes **will not** be included in the exams

1-D codes

- Code 39 = Code 3-of-9; alphanumeric (full ASCII) bar code;
  applications in inventory, asset tracking, ID badges

1-D codes

- Code 39 = Code 3-of-9; alphanumeric (full ASCII) bar code;
  applications in inventory, asset tracking, ID badges
- Interleaved 2 of 5 ; Numeric-only bar code, industrial applications, carton labeling, laboratory uses

1-D codes

- Code 39 = Code 3-of-9; alphanumeric (full ASCII) bar code;
  applications in inventory, asset tracking, ID badges
- Interleaved 2 of 5 ; Numeric-only bar code,
  industrial applications, carton labeling, laboratory uses
- UPC (Universal Product Code), Numeric Bar code;
  used in retail product labeling.

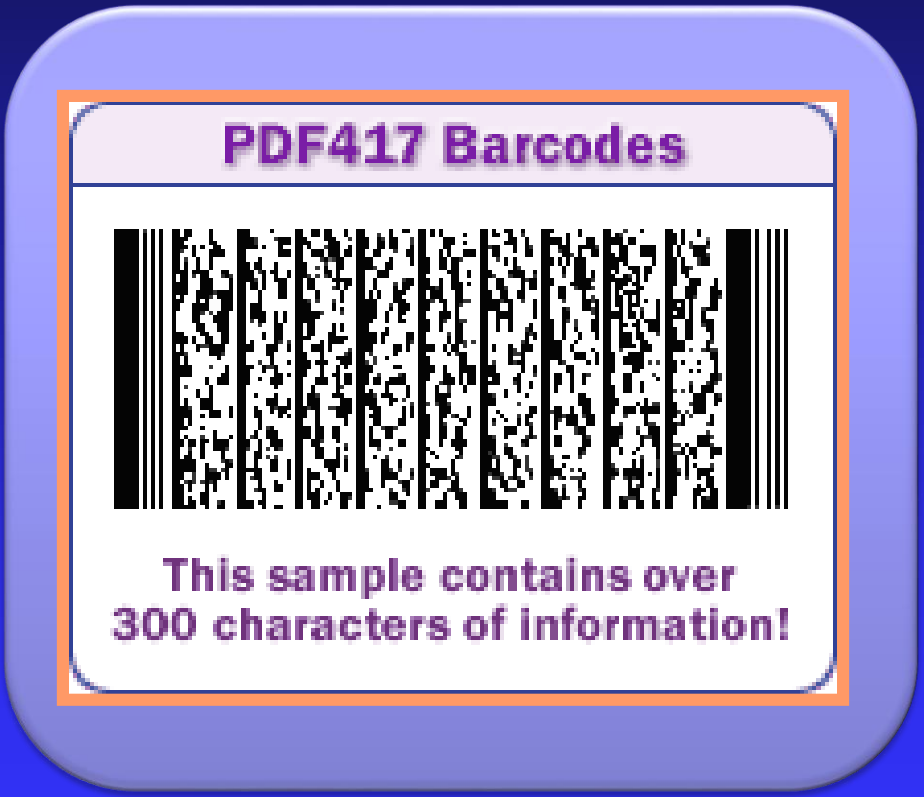
1-D codes

- Code 39 = Code 3-of-9; alphanumeric (full ASCII) bar code;
  applications in inventory, asset tracking, ID badges
- Interleaved 2 of 5 ; Numeric-only bar code,
  industrial applications, carton labeling, laboratory uses
- UPC (Universal Product Code), Numeric Bar code;
  used in retail product labeling.
- Code 128 – Alphanumeric (full ASCII);
  applications in Shipping, Warehouse management.

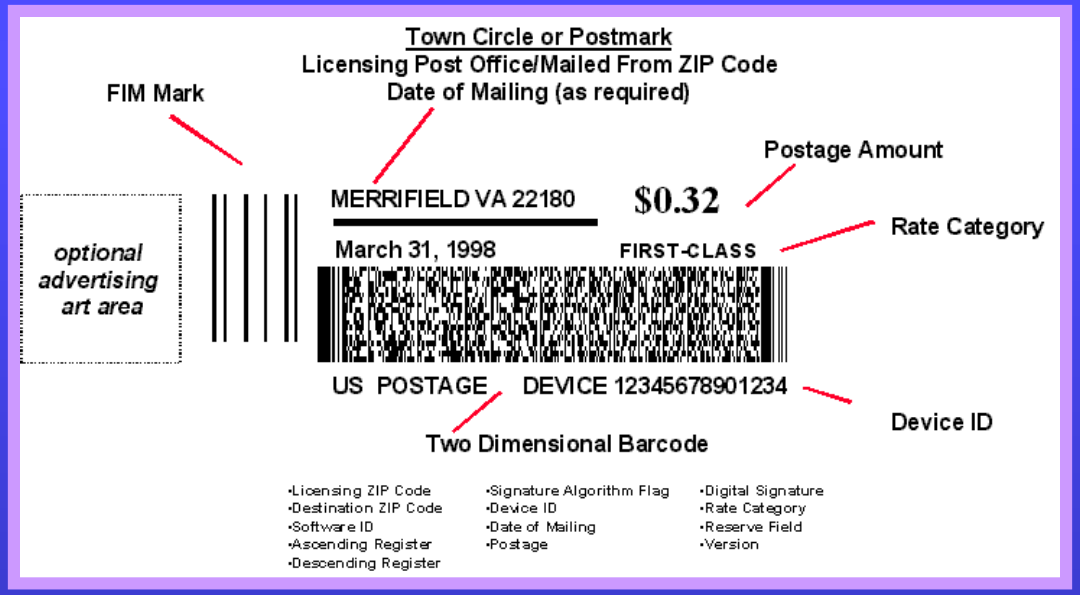
2-D code

- -PDF417;
  applications web postage stamp……..

PDF417


PDF417 Barcodes
This sample contains over
300 characters of information!

PDF417


Town Circle or Postmark
Licensing Post Office/Mailed From ZIP Code
Date of Mailing (as required)
FIM Mark
Postage Amount
optional advertising art area
MERRIFIELD VA 22180
$0.32
March 31, 1998
FIRST-CLASS
Rate Category
US POSTAGE
DEVICE 12345678901234
Device ID
Two Dimensional Barcode
•Licensing ZIP Code
•Destination ZIP Code
•Software ID
•Ascending Register
•Descending Register
•Signature Algorithm Flag
•Device ID
•Date of Mailing
•Postage
•Digital Signature
•Rate Category
•Reserve Field
•Version

Alphanumeric codes

- Used to print, teletype or view information or other means of human alpha-numeric communication.

Alphanumeric codes

- Used to print, teletype or view information or other means of human alpha-numeric communication.
  - ASCII-7 bits
  - ASCII-8 bits (EBCIDIC)
  - UniCode

ASCII

- ASCII (American Standard Code for Information Interchange):

  7 bits = 128 characters (now Super ASCII use all 8-bits).
- EBCIDIC (Extended BCD Interchange Code):

  8 bits = 256 characters.

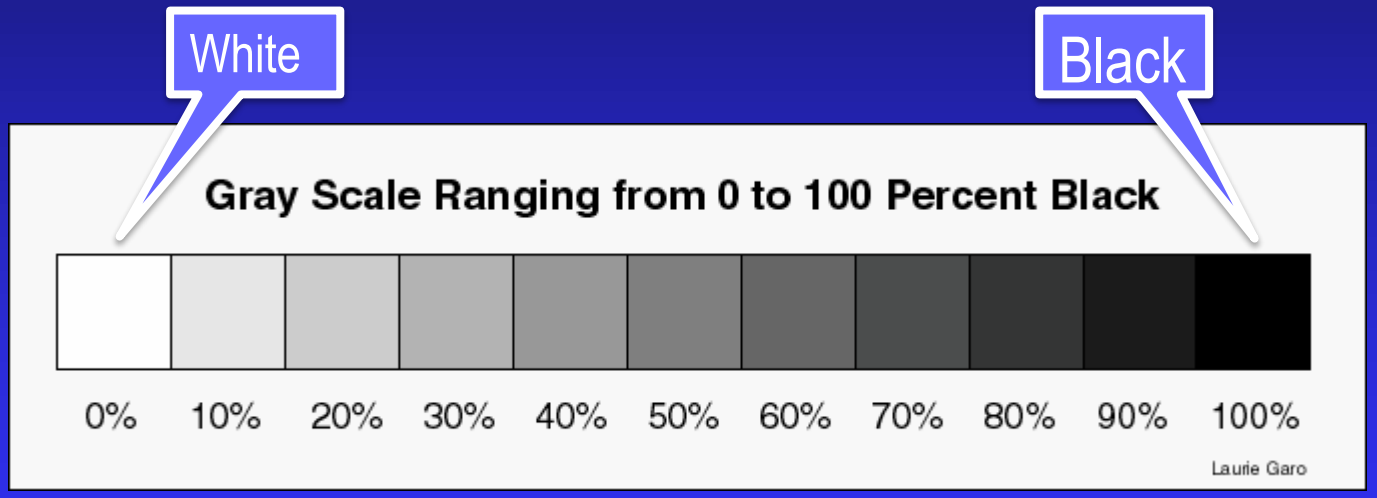
ASCII

	000 0	001 1	010 2	011 3	100 4	101 5	110 6	111 7
0000 0	NUL 0	DLE 16	SP 32	0 48	@ 64	P 80	` 96	p 112
0001 1	SOH 1	DC1 17	! 33	1 49	A 65	Q 81	a 97	q 113
0010 2	STX 2	DC2 18	" 34	2 50	B 66	R 82	b 98	r 114
0011 3	ETX 3	DC3 19	# 35	3 51	C 67	S 83	c 99	s 115
0100 4	EOT 4	DC4 20	$ 36	4 52	D 68	T 84	d 100	t 116
0101 5	ENQ 5	NAK 21	% 37	5 53	E 69	U 85	e 101	u 117
0110 6	ACK 6	SYN 22	& 38	6 54	F 70	V 86	f 102	v 118
0111 7	BEL 7	ETB 23	' 39	7 55	G 71	W 87	g 103	w 119
1000 8	BS 8	CAN 24	(40	8 56	H 72	X 88	h 104	x 120
1001 9	HT 9	EM 25	) 41	9 57	I 73	Y 89	i 105	y 121
1010 A	LF 10	SUB 26	* 42	: 58	J 74	Z 90	j 106	z 122
1011 B	VT 11	ESC 27	+ 43	; 59	K 75	[91	k 107	{ 123
1100 C	FF 12	FS 28	´ 44	< 60	L 76	\ 92	l 108	| 124
1101 D	CR 13	GS 29	- 45	= 61	M 77	] 93	m 109	} 125
1110 E	SO 14	RS 30	. 46	> 62	N 78	^ 94	n 110	~ 126
1111 F	SI 15	US 31	/ 47	? 63	O 79	_ 95	o 111	DEL 127

EBCIDIC (8-bit ASCII)

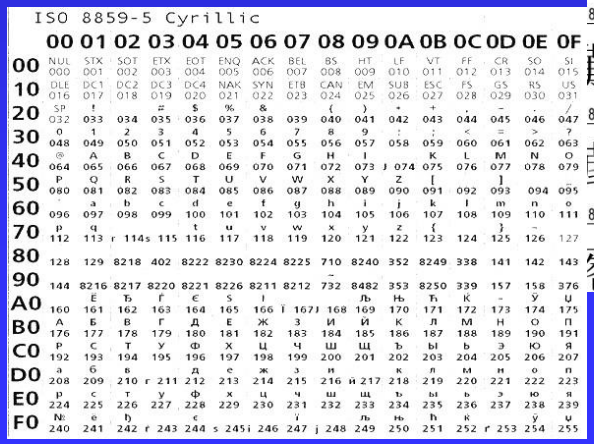
- EBCIDIC (Extended BCD Interchange Code): 8 bits = 256 characters.

EBCIDIC (8-bit ASCII)



Unicode

- Unicode (New standard for 16 – bit alphanumeric codes)



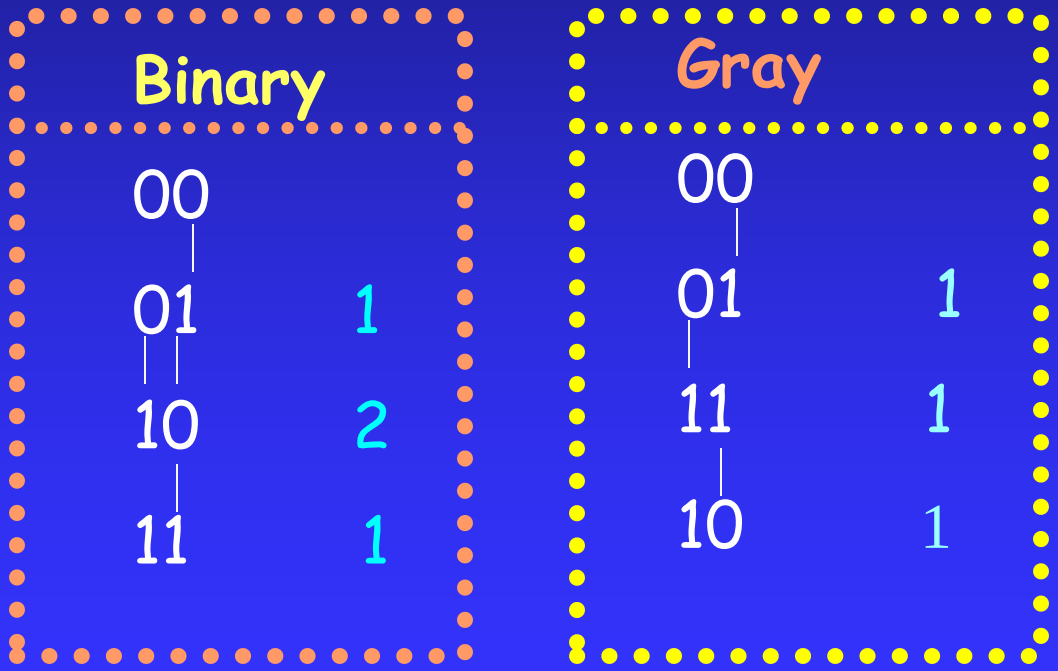
A useful code is the Gray

- Gray code is of cyclic nature having the following property:

  "From one number to the next, the Gray code changes only one bit"

Bit changes …

- Gray code is of cyclic nature having the following property:
- "From one number to the next, the Gray code changes only one bit"



Gray Code …

- The Gray code is used for labeling Karnaugh maps for logic circuit simplification, for routing in parallel computer systems, etc……..

Gray Codes

$$G_1 = \begin{cases} 0 \\ 1 \end{cases} \qquad G_2 = \begin{cases} 0\,\boxed{0} = 0 \\ 0\,\boxed{1} = 1 \\ 1\,\boxed{1} = 2 \\ 1\,\boxed{0} = 3 \end{cases}$$

G_1 (over the boxed bits) and G_1^{ref} (under the boxed bits)

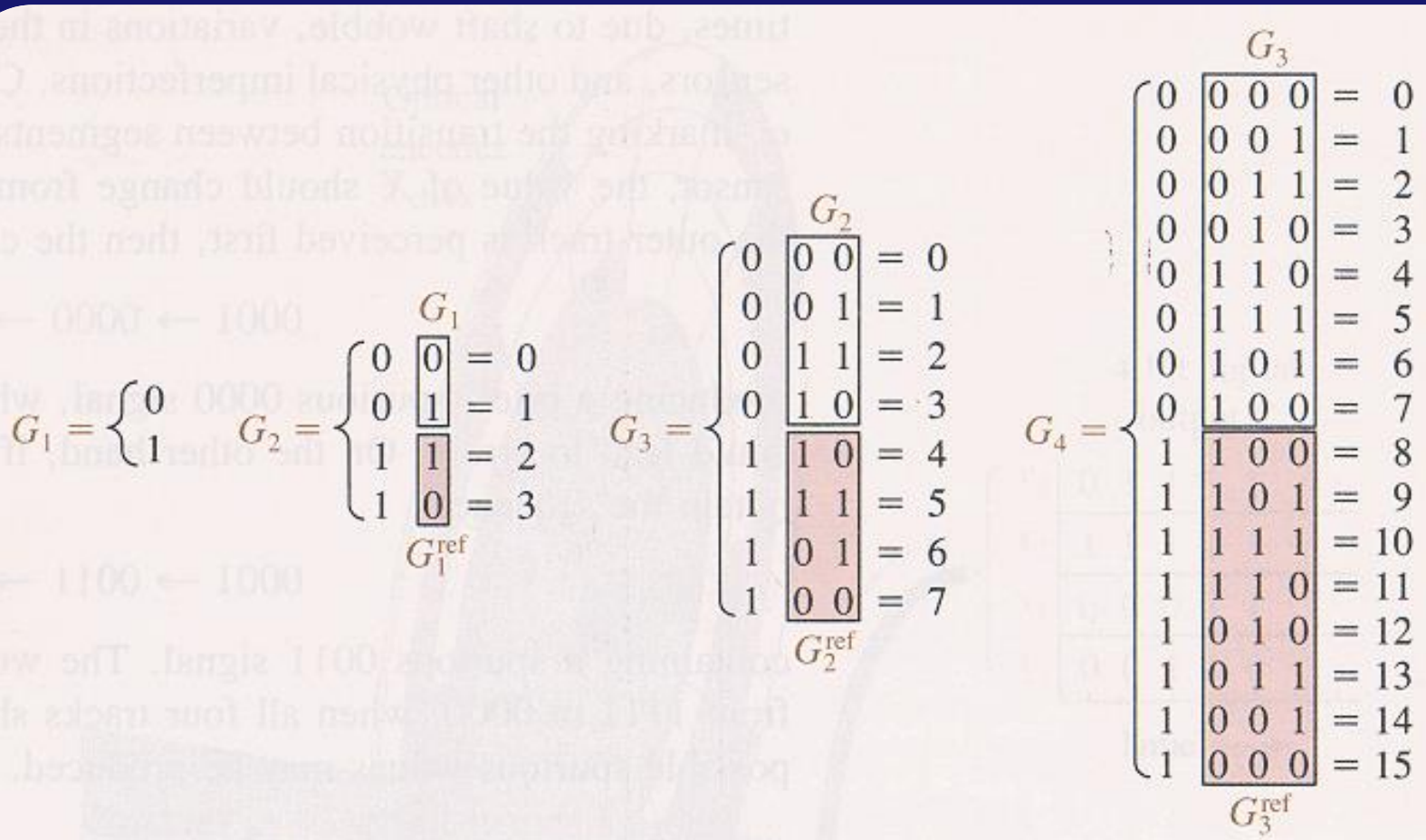
Gray Codes

$$G_1 = \begin{cases} 0 \\ 1 \end{cases}$$

$$G_2 = \begin{cases} 0 & \boxed{0} & = 0 \\ 0 & \boxed{1} & = 1 \\ 1 & \boxed{1} & = 2 \\ 1 & \boxed{0} & = 3 \end{cases} \quad \begin{matrix} \\ \\ \\ \\ G_1^{\text{ref}} \end{matrix} \quad \begin{matrix} G_1 \\ \\ \\ \\ \\ \end{matrix}$$

$$G_3 = \begin{cases} 0 & \boxed{0\ 0} & = 0 \\ 0 & \boxed{0\ 1} & = 1 \\ 0 & \boxed{1\ 1} & = 2 \\ 0 & \boxed{1\ 0} & = 3 \\ 1 & \boxed{1\ 0} & = 4 \\ 1 & \boxed{1\ 1} & = 5 \\ 1 & \boxed{0\ 1} & = 6 \\ 1 & \boxed{0\ 0} & = 7 \end{cases} \quad \begin{matrix} \\ \\ \\ \\ \\ \\ \\ \\ G_2^{\text{ref}} \end{matrix} \quad \begin{matrix} G_2 \\ \\ \\ \\ \\ \\ \\ \\ \\ \end{matrix}$$

Gray Codes


$G_1 = \begin{cases} 0 \\ 1 \end{cases}$
$G_2 = \begin{cases} 0\ \boxed{0} = 0 \\ 0\ \boxed{1} = 1 \\ 1\ \boxed{1} = 2 \\ 1\ \boxed{0} = 3 \end{cases}$
G_1
G_1^{ref}
$G_3 = \begin{cases} 0\ \boxed{0\ 0} = 0 \\ 0\ \boxed{0\ 1} = 1 \\ 0\ \boxed{1\ 1} = 2 \\ 0\ \boxed{1\ 0} = 3 \\ 1\ \boxed{1\ 0} = 4 \\ 1\ \boxed{1\ 1} = 5 \\ 1\ \boxed{0\ 1} = 6 \\ 1\ \boxed{0\ 0} = 7 \end{cases}$
G_2
G_2^{ref}
$G_4 = \begin{cases} 0\ \boxed{0\ 0\ 0} = 0 \\ 0\ \boxed{0\ 0\ 1} = 1 \\ 0\ \boxed{0\ 1\ 1} = 2 \\ 0\ \boxed{0\ 1\ 0} = 3 \\ 0\ \boxed{1\ 1\ 0} = 4 \\ 0\ \boxed{1\ 1\ 1} = 5 \\ 0\ \boxed{1\ 0\ 1} = 6 \\ 0\ \boxed{1\ 0\ 0} = 7 \\ 1\ \boxed{1\ 0\ 0} = 8 \\ 1\ \boxed{1\ 0\ 1} = 9 \\ 1\ \boxed{1\ 1\ 1} = 10 \\ 1\ \boxed{1\ 1\ 0} = 11 \\ 1\ \boxed{0\ 1\ 0} = 12 \\ 1\ \boxed{0\ 1\ 1} = 13 \\ 1\ \boxed{0\ 0\ 1} = 14 \\ 1\ \boxed{0\ 0\ 0} = 15 \end{cases}$
G_3
G_3^{ref}

Binary and BCD numbers

- Bits obtained from conversion, of binary numbers, are binary digits

Binary and BCD numbers

- Bits obtained from conversion, of binary numbers, are binary digits
- Bits obtained from coding (BCD) are combinations of 1's and 0's arranged according to the rules of the code (BCD).

Example-1

- $(13)_{10} = (1101)_2$,

Example-1

- $(13)_{10} = (1101)_2$,

but,

$(13)_{10} = (0001\ \ 0011)_{BCD}$

$(1\qquad 3)_{10}$

Example-2

- $(7)_{10} = (111)_2$,

Example-2

- $(7)_{10} = (111)_2$,

but,

$(0111)_{BCD}$

7_{10}

Another Example

- $(15)_{10} = (1111)_2$,

but,

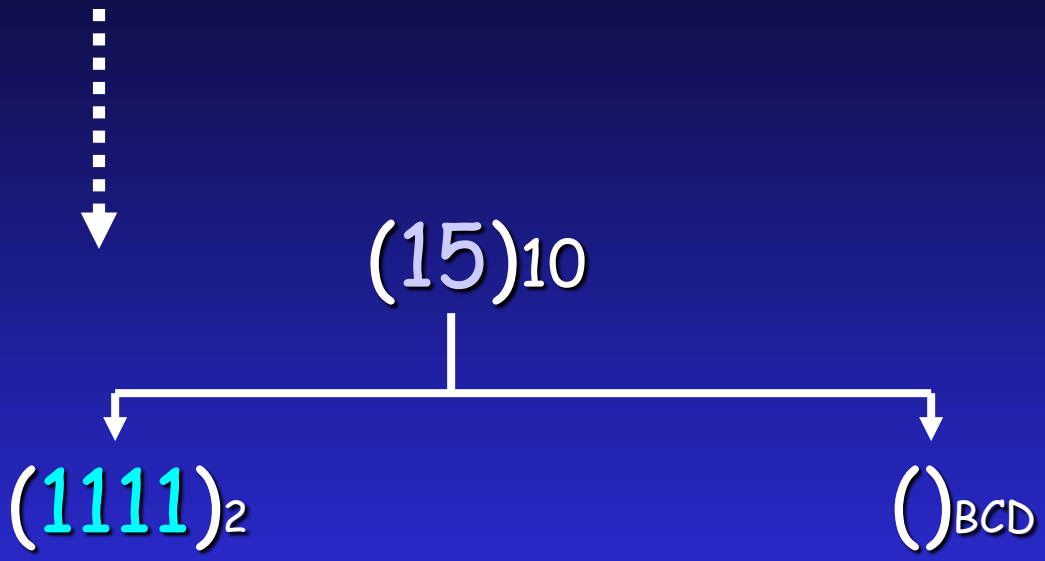
$(15)_{10} = (0001\ \ 0101)_{BCD}$

$(1\ \ \ \ 5)_{10}$

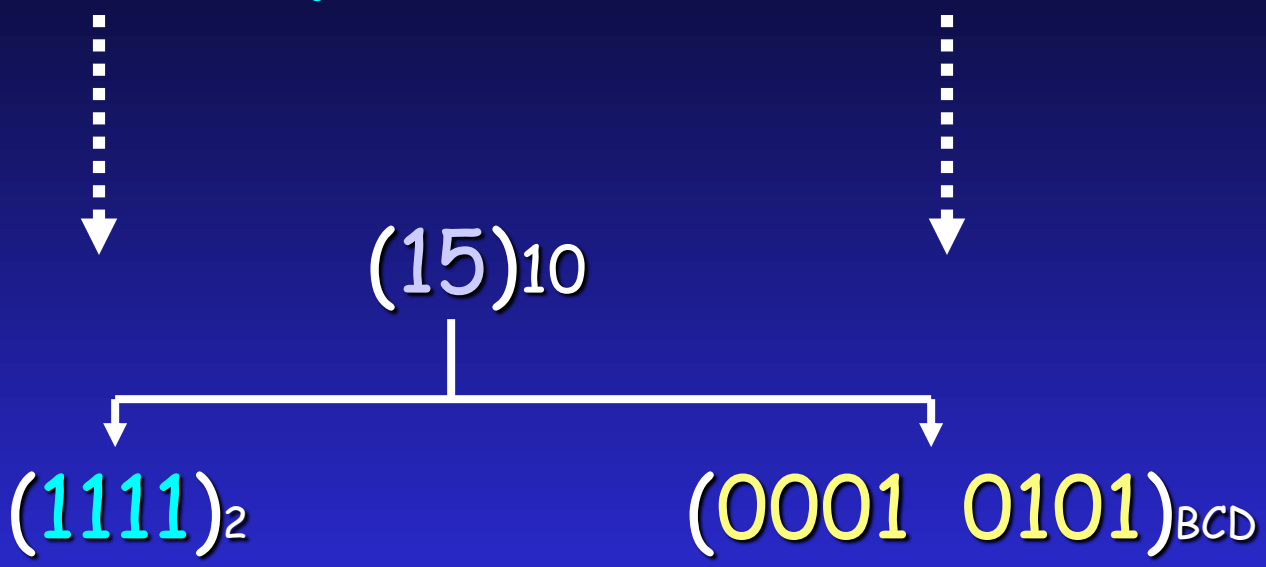
Binary & BCD

$(15)_{10}$

Binary & BCD



Binary & BCD



END

New codes …

Code-A

	A
0	0000
1	0001
2	0010
	0011
	0100
3	0101
4	0110
	0111
	1000
5	1001
6	1010
	1011
	1100
7	1101
8	1110
9	1111

Symmetric code

Code-B

	B
0	0000
1	0001
2	0010
	0011
	0100
	0101
3	0110
4	0111
5	1000
6	1001
	1010
	1011
	1100
7	1101
8	1110
9	1111

Symmetric code

Code-C

	C
0	0000
1	0001
2	0010
3	0011
	0100
	0101
	0110
4	0111
5	1000
	1001
	1010
	1011
6	1100
7	1101
8	1110
9	1111

Symmetric code