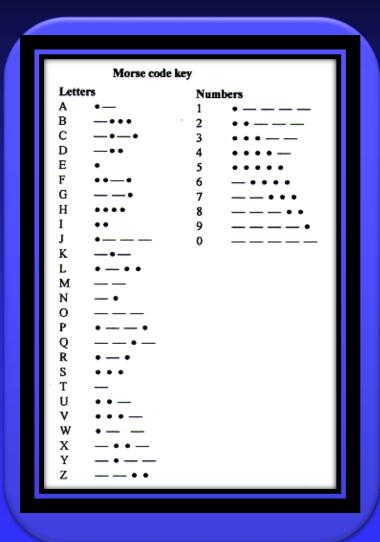
Codes

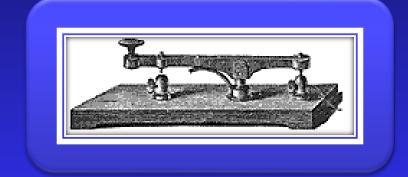
Codes

Codes are groupings of symbols that are used for information exchange...

Examples?

Example: Morse code (1844)





Example: Braille code

```
A B C D E F G H I J

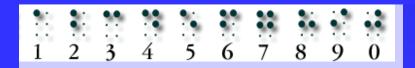
:: :: :: :: :: :: :: :: :: :: ::

K L M N O P Q R S T

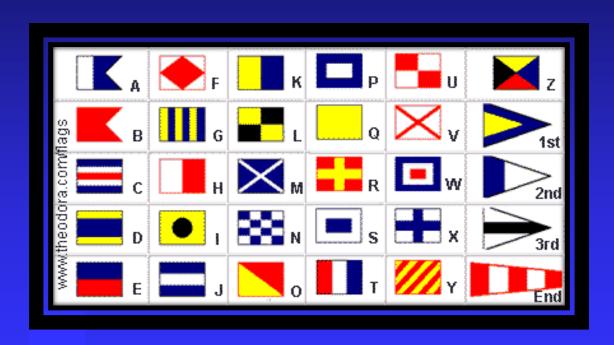
:: :: :: :: :: :: :: :: :: :: ::

U V X Y Z W

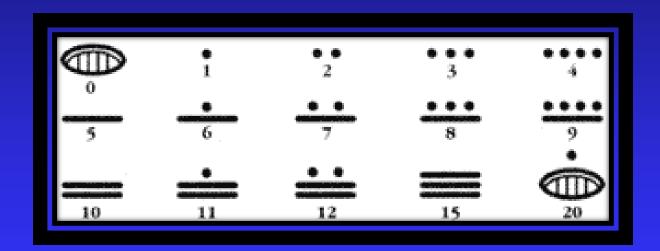
:: :: :: :: :: :: :: :: ::
```



Example: Nautical flag code



Example: Maya code-numbers



Example: Maya code (?)



Binary Codes

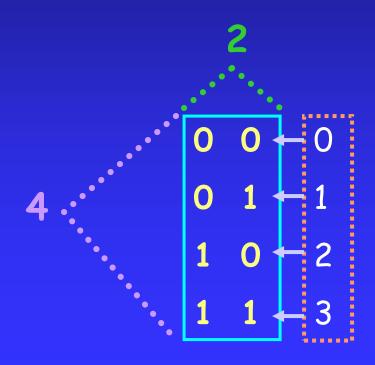
To represent a group of 2ⁿ distinct elements in a binary code, it requires a minimum of n-bits.

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: <u>the zero</u> and <u>the one</u>.
- 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

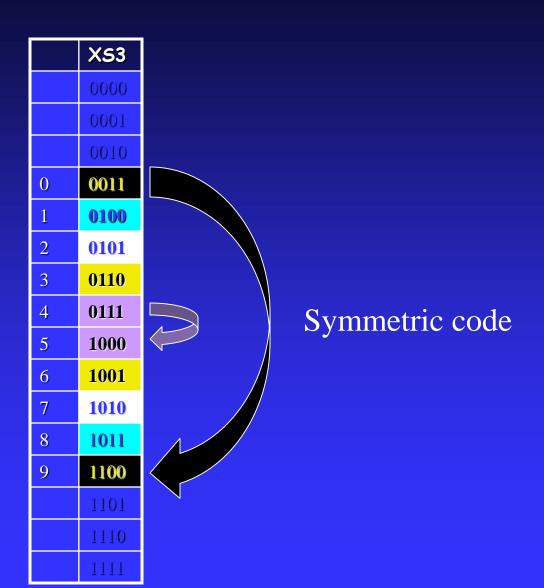
Binary Coded Decimal (BCD)

BCD	
0000	
0001	
0010	
0011	
0100	
0101	
0110	
0111	
1000	
1001	
1010	r
1011	t
1100	
1101	S
1110	6
1111	C
	0000 0001 0010 0011 0100 0101 0110 0110 1001 1010 1011 1100 1111 1100 1110 1110

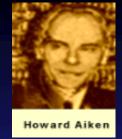
Excess-3 (XS3)

	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)



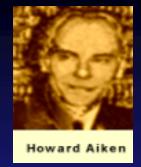
Aiken code



	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



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

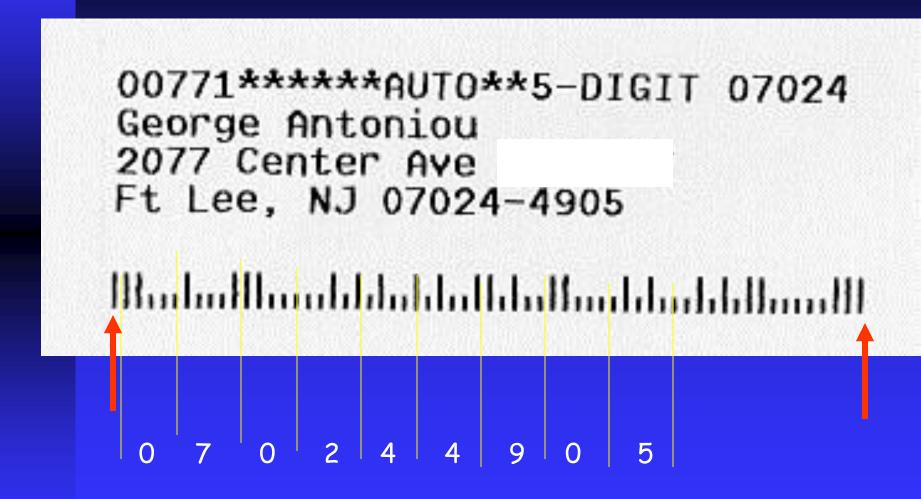
2-out-of-5

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



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

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- Interleaved 2 of 5; Numeric-only bar code, industrial applications, carton labeling, laboratory uses

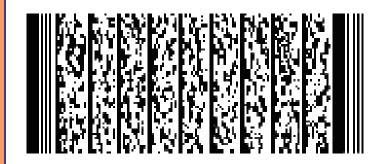
- Code 39 = Code 3-of-9; alphanumeric (full ASCII) bar code; applications in inventory, asset tracking, ID badges
- Interleaved 2 of 5; Numeric-only bar code, industrial applications, carton labeling, laboratory uses
- UPC (Universal Product Code), Numeric Bar code; used in retail product labeling.

- Code 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.

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

PDF417

PDF417 Barcodes



This sample contains over 300 characters of information!

PDF417



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.

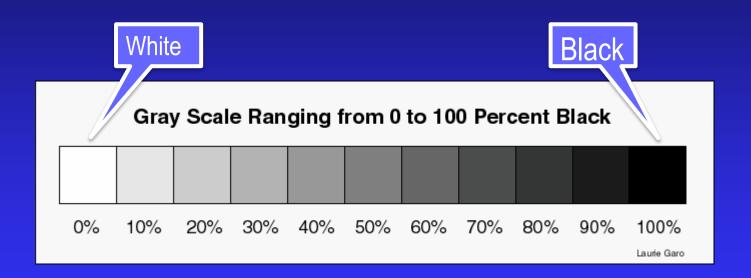
ASCII

Г			T000 L001				010 011 100				101 110				111			
			000		001		امين	_	011	_	100		101		1 1 1		111	
ŀ				0		1		2		3		4		5		6		7
	0000		NUI		DL		SP		0		@		P		ļ`		P	
L		0		0		16		32		48		64		80		96		112
	0001		SOF	ŀ	DC:		!		1		Α		Q		a		q	
IL		1		1		17		33		49		65		81		97		113
	0010		STX		DC2	2	**		2		В		R		b		r	
		2		2		18		34		50		66		82		98		114
	0011		ETX	ζ	DC	3	#		3		С		S		С		s	
		3		3		19		35		51		67		83		99		115
l	0100		EO?	Γ	DC4	1	\$		4		D		Т		d		t	
		4		4		20		36		52		68		84	_	100		116
lt	0101		ENG	<u> </u>	NA	ĸ	%		5		Е		U		е		u	
		5		` 5		21		37	-	53	-	69	-	85	-	101	-	117
lt	0110		ACI	7	SYI		æ		6		F		v		f		v	
П		б		6	~	22	"	38		54	1	70	١.	86	•	102	'	118
lt	0111		BEI		ETI		,		7		G		w		g		w	
П	0111	7		7		23		39	ľ	55	"	71	''	87	6	103	"	119
lŀ	1000	•	BS		CAI		(8		Н		x		h	105	x	
П		8		8	023	24	`	40	٦	56	**	72		88	**	104	_	120
lŀ	1001		НТ		EM		5		9		I		Y		i		y	-100
П	1001	9	111	9	1.171	25	l'	41	-	57	*	73	*	89	*	105	"	121
╟	1010		LF		SUE		*	11	:		J	-/-	z	-0/	j	107	z	121
	1010	Α	LL	10	1901	2 6		42	١.	58	J	74		90	J	106	*	122
╟	1011		VT	10	ESC		+	74		70	К	/-	г	70	k	100	,	122
Ш	1011	В	V 1	11	ESC	27	+	43	;	59	'V	75	Į L	91	K	107	{	123
╟	1100		EE	11	TCC	41	,	47		22	L	-/-	١	71	1	107	_	123
Ш	1100	С	FF	12	FS	28		44	<	60	ւ	76	١,	92	1	108	П	124
╟	1101			12	~~	20		44		00		/0	,	92	_	100	_	124
	1101	г.	CR	12	GS	20	-	4.5	=	z 1	M	~~]	02	m	1.00	}	125
ŀ	1110	D		13		29		45		61		77	_	93		109		125
П	1110	_	so		RS		•		>		N		^_		n		~	
1		Е		14		30		46	_	62	_	78		94		110		126
	1111	_	SI		US		/		?		0		_		0		DE	
L		F		15		31		47		63		79		95		111		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)

							1F90 8080 1F91 8081 1F92 8082 1F93 8083 1F94 8084 1F95 8085 1F96 8086 1F97 8087
							t t t t t t t
							1F98 8088 1F99 8089 1F9A 8090 1F9B 8091 1F9C 8092 1F9D 8093 1F9E 8094 1F9F 8095
							`Hi 'Hi "Hi "Hi "Hi "Hi "Hi "Hi
							1FAO 8096 1FA1 8097 1FA2 8098 1FA3 8099 1FA4 8100 1FA5 8101 1FA6 8102 1FA7 8103
							ý
							1FAS 8104 1FA9 8105 1FAA 8105 1FAB 8107 1FAC 8108 1FAD 8109 1FAE 8110 1FAF 8111
							ία 'α 'α 'α 'α 'α 'α
							1FB0 8112 1FB1 8113 1FB2 8114 1FB3 8115 1FB4 8116 1FB5 8117 1FB6 8118 1FB7 8119
							u u y y y w u y
							1FBB 8120 1FB9 8121 1FBA 8122 1FBB 8123 1FBC 8124 1FBD 8125 1FBE 8126 1FBF 8127 A A A A A
E/V	11/2	100	ПЖ	ПШ		口分区	
·····································	管	44	即	崩	古古	啦	125 176 177
				-124	山十	71724	8136 1FC9 8137 1FCA 8138 1FCB 8139 1FCC 8140 1FCD 8141 1FCE 8142 1FCF 8143
8071	8072	8073	8074	8075	8076	8077	8078 'E 'H 'H H " " "
t→ lt	пш	пин	nd-	ннэ	HYH	н=	8144 FD1 8145 1FD2 8146 FD3 8147 1FD4 8148 FD5 8149 1FD6 8159 1FD7 8151
	腲		開出	服	捐設	铝	日元
	AIN	JHL	11/1	MX	HY	加	T T T T T T T T T T T T T T T T T T T
ISO 8859-5 Cyrillic 8171	8172	8173	8174	8175	8176	8177	8178 Ī 'I 'I 'n/a ' " ' *
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F +H		1.7.	п.,	X + + .	.11.7	otto F	8160 1FE1 8161 1FE2 8162 1FE3 8163 1FE4 8164 1FE5 8165 1FE6 8166 1FE7 8167
00 NUL STX SOT ETX EOT ENQ ACK BEL BS HT LF VT FF CR SO SI	伍	丰伍	黒 伍	14名	豐倍	二四 名	τ ὑ ὑ ὑ ῥ ῷ ΰ
10 DLE DC1 DC2 DC3 DC4 NAK SYN ETB CAN EM SUB ESC FS GS RS US TL	انا		74		豆巴	豆巴	8168 1FE9 8169 1FEA 8170 1FEB 8171 1FEC 8172 1FED 8173 1FEE 8174 1FEF 8175
20 SP : 5 % & () + + + + + + + + + + + + + + + + + +	8272	8273	8274	8275	8276	8277	8278 Y Y Y P ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '
30 0 1 2 3 4 5 6 7 8 9 : ; < = > 7							8176 1FF1 8177 1FF2 8178 1FF3 8179 1FF4 8180 1FF5 8181 1FF6 8182 1FF7 8183
40 064 065 066 067 068 069 070 071 072 073 J 074 075 076 077 078 079	堇	書	71	井	武	芫	n/a ὰ ῷ ῷ ự n/a ῷ ῷ π/a ῷ ῷ π/a το ῷ ῷ siss/ lfFp siss
50 P Q R S T U V W X Y Z [] 1 O92 093 094 095	土	显	扩大	忍	吟	1円	J
60 096 097 098 099 100 101 102 103 104 105 106 107 108 109 110 111 8371	8372	8373	8374	8375	8376	8377	8378 O O O O O n/a
70 p q t u v w x y z { } }				2270			
80 128 129 8218 402 8222 8230 8224 8225 710 8240 352 8249 338 141 142 143	古	盐	盐	李	芸	井	苗
90 144 8216 8217 8220 8221 8226 8211 8212 732 8482 353 8250 339 157 158 376	沢	歧人	成	关	学	里	
A0 160 161 162 163 164 165 166 1 167J 168 169 170 171 172 173 174 175							
ВО А Б В Г Д Е Ж З И Й К Л М Н О П							

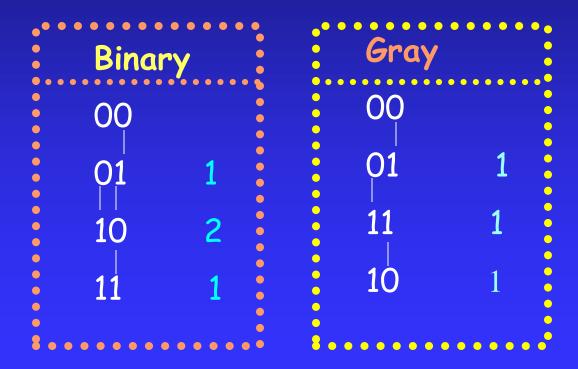
A useful code is the Gray

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

$$G_{1} = \begin{cases} 0 \\ 1 \end{cases} \qquad G_{2} = \begin{cases} 0 & \boxed{0} = 0 \\ 0 & \boxed{1} = 1 \\ 1 & \boxed{1} = 2 \\ 1 & \boxed{0} = 3 \end{cases}$$

Gray Codes

$$G_{1} = \begin{cases} 0 & G_{2} = \begin{cases} 0 & \boxed{0} = 0 \\ 0 & \boxed{1} = 1 \\ 1 & \boxed{1} = 2 \\ 1 & \boxed{0} = 3 \end{cases} \qquad G_{3} = \begin{cases} 0 & 0 & 0 & 0 = 0 \\ 0 & \boxed{0} & 1 & = 1 \\ 0 & \boxed{1} & 1 & = 2 \\ 0 & \boxed{1} & 0 & = 3 \\ 1 & \boxed{1} & 0 & = 4 \\ 1 & \boxed{0} & 1 & = 6 \\ 1 & \boxed{0} & 0 & = 7 \end{cases}$$

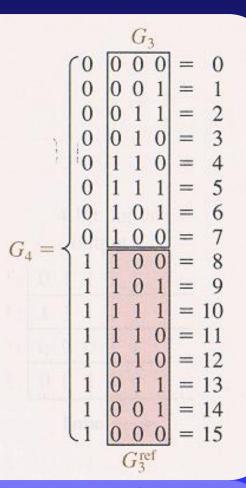
$$G_{3} = \begin{cases} 0 & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} \\ 0 & \boxed{0} & \boxed{1} & \boxed{0} & \boxed{0} \\ 0 & \boxed{1} & \boxed{1} & \boxed{1} & \boxed{0} & \boxed{0} \\ 1 & \boxed{1} & \boxed{1} & \boxed{0} & \boxed{0} & \boxed{0} \\ 1 & \boxed{1} & \boxed{1} & \boxed{0} & \boxed{0} & \boxed{0} \\ 1 & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} \end{cases}$$

Gray Codes

$$G_{1} = \begin{cases} 0 & G_{2} = \begin{cases} 0 & \boxed{0} = 0 \\ 0 & \boxed{1} = 1 \\ 1 & \boxed{1} = 2 \\ 1 & \boxed{0} = 3 \end{cases}$$

$$G_{3} = \begin{cases} 0 & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} \\ 0 & \boxed{0} & \boxed{1} & \boxed{1} & \boxed{1} \\ 0 & \boxed{1} & \boxed{1} & \boxed{1} & \boxed{2} \\ 0 & \boxed{1} & \boxed{0} & \boxed{0} & \boxed{3} \\ 1 & \boxed{1} & \boxed{0} & \boxed{0} & \boxed{4} \\ 1 & \boxed{1} & \boxed{1} & \boxed{0} & \boxed{1} & \boxed{6} \\ 1 & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{7} \end{cases}$$

$$G_{2}^{\text{ref}}$$



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).

-(13)10 = (1101)2,

```
(13)10 = (1101)2,
but,
(13)10 = (0001 0011)BCD
(1 3)10
```

$$-$$
 (7)10 = (111)2,

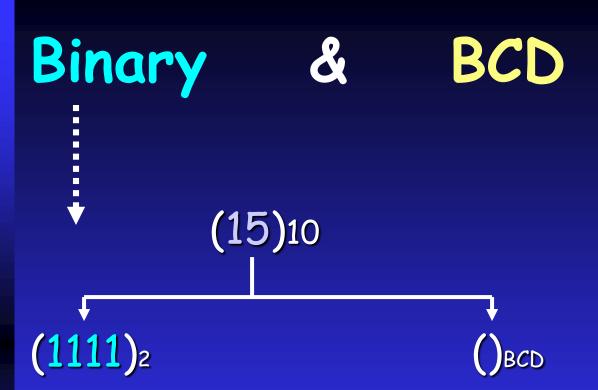
```
(7)10 = (111)2,but,(0111)BCD710
```

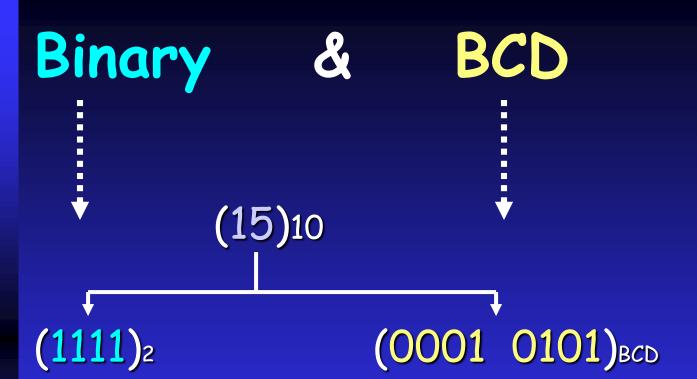
Another Example

```
(15)10 = (1111)2,
but,
(15)10 = (0001 0101)BCD
(1 5)10
```

Binary & BCD

(15)10







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

	В
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

	С
0	
0	0000
1	0001
2	0010
3	0011
	0100
	0101
	0110
4	0111
5	1000
	1001
	1001
	1010
6	1010
6 7	1010 1011
	1010 1011 1100

Symmetric code