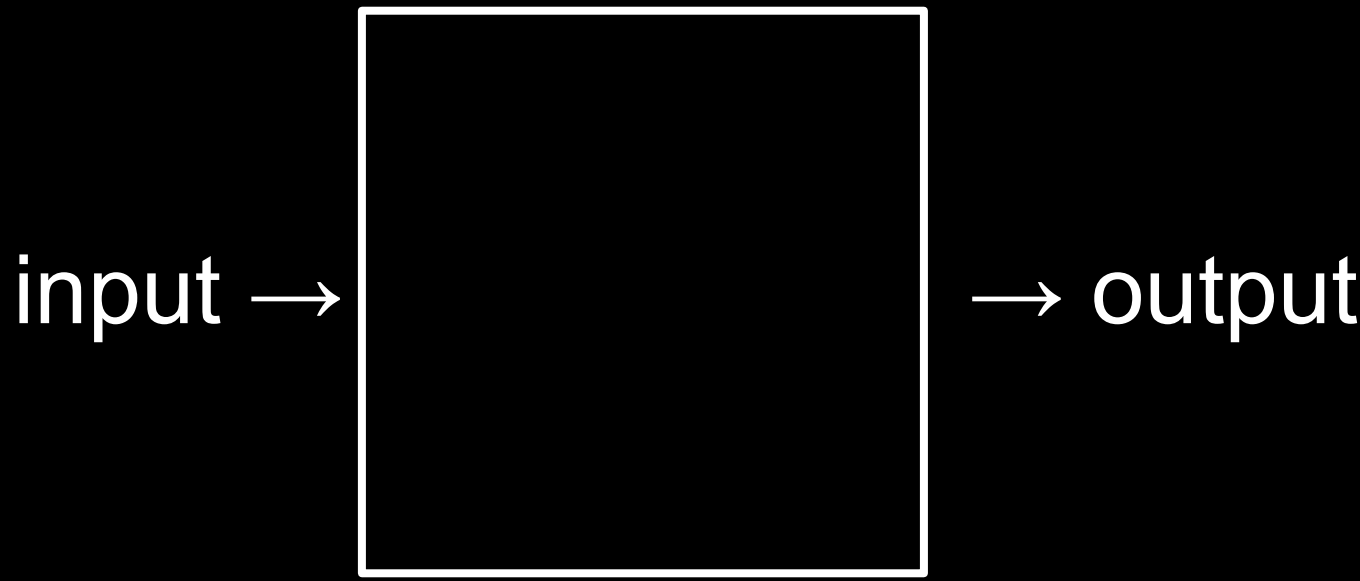
🚀Counting Beyond 10

A Journey Through Numbers & Their Hidden Languages

Amin Hashemi

Sharif University of Technology

problem solving


input →
→ output

Unary
(base-1)

binary

(base-2)

binary digit

bi t

bit

1

decimal

(base-10)

123

123

10 1

123

100 10 1

123

100 10 1

123

100 × 1

100 10 1

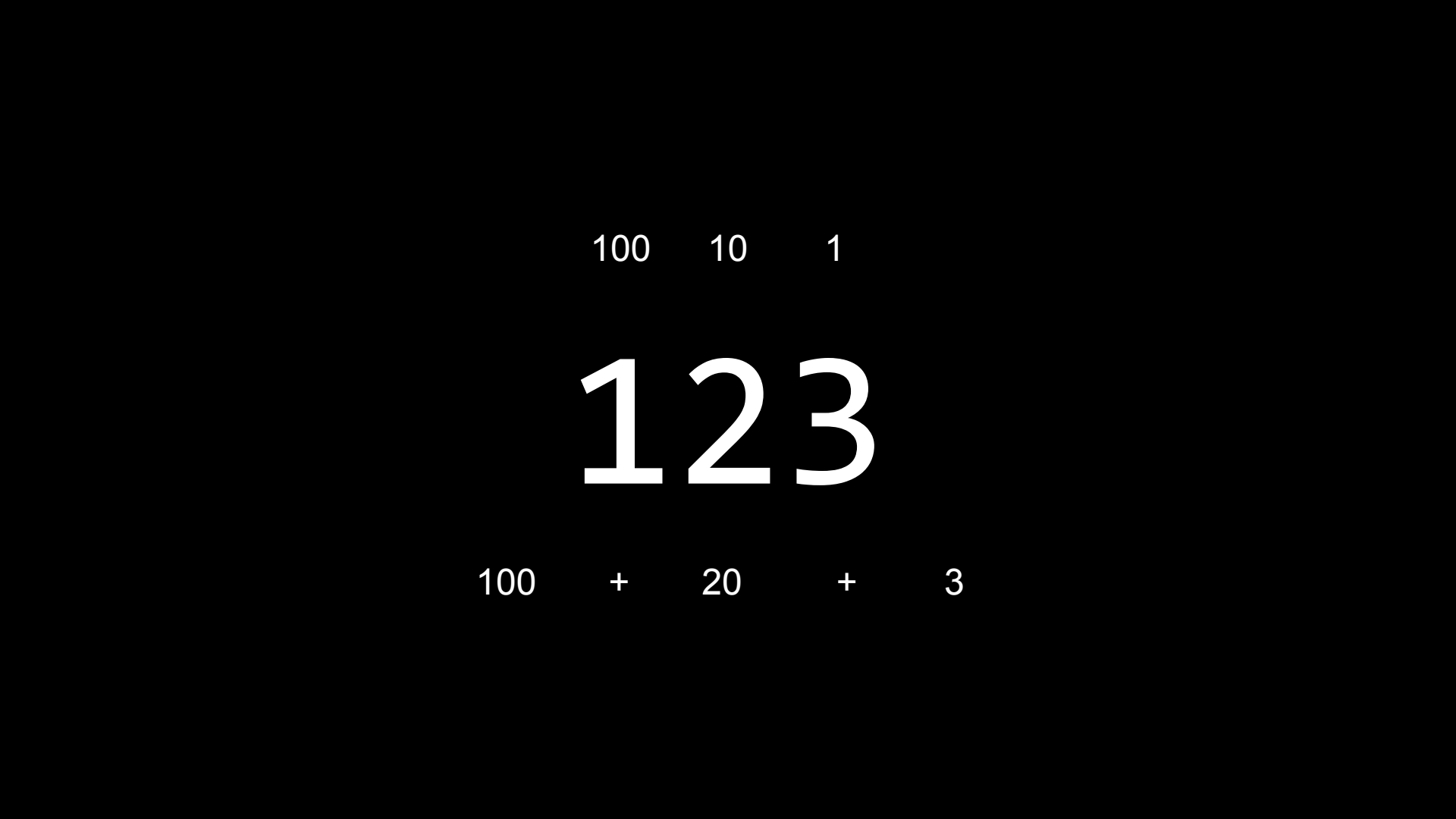
123

100 × 1 + 10 × 2

100 10 1

123

100 × 1 + 10 × 2 + 1 × 3


100 10 1
123
100 + 20 + 3

123

100 10 1

###

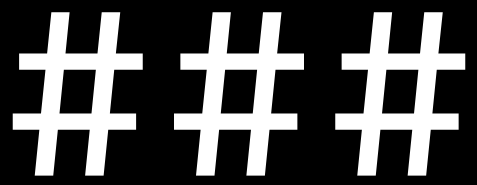
10^2 10^1 10^0

###

2^2 2^1 2^0

###

4 2 1




4 2 1
000

4 2 1

001

4 2 1

010

4 2 1

011

4 2 1

100

4 2 1

101

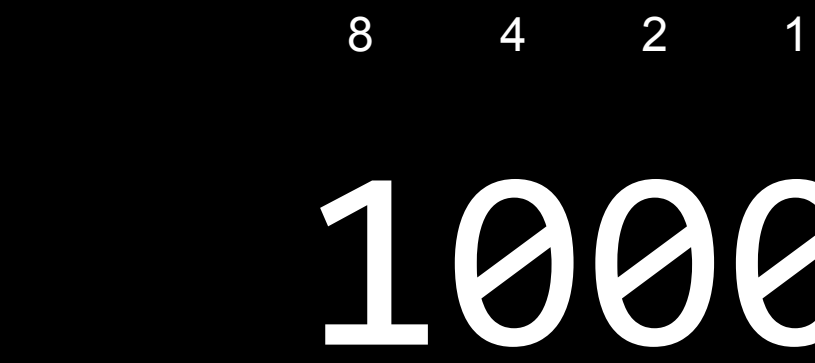
4 2 1

110

4 2 1

111

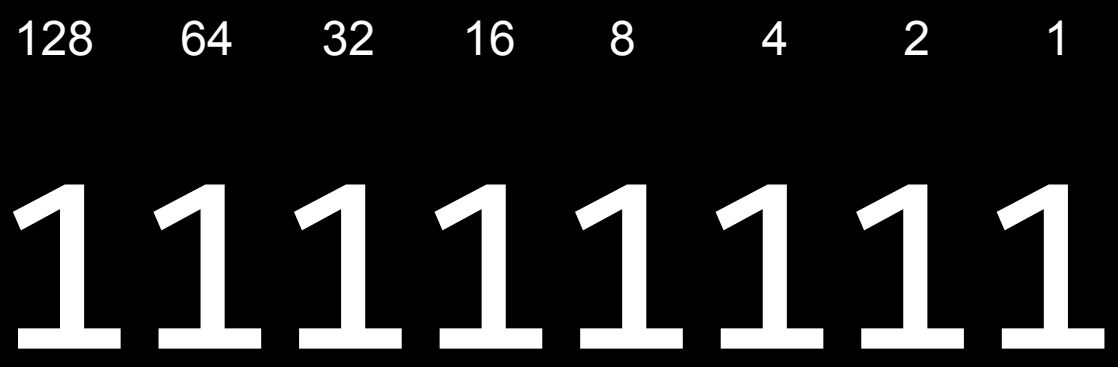

4 2 1
000


8 4 2 1
1000

byte

128 64 32 16 8 4 2 1

0 0 0 0 0 0 0 0


128 64 32 16 8 4 2 1
11111111

A

128 64 32 16 8 4 2 1

01000001

65

ASCII

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

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

01001000 01001001 00100001

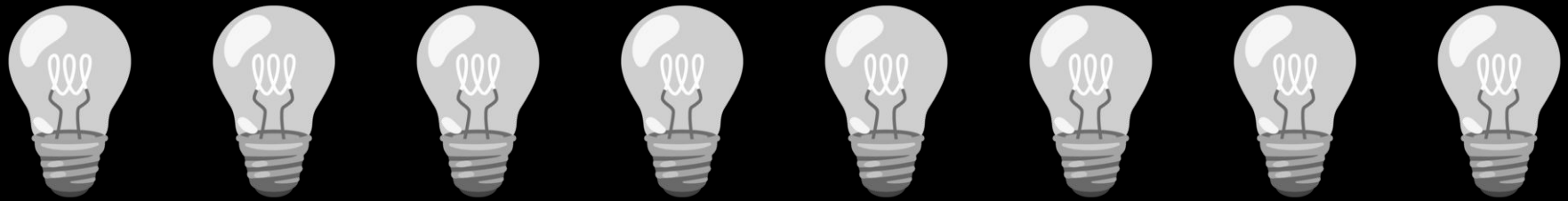
72 73 33

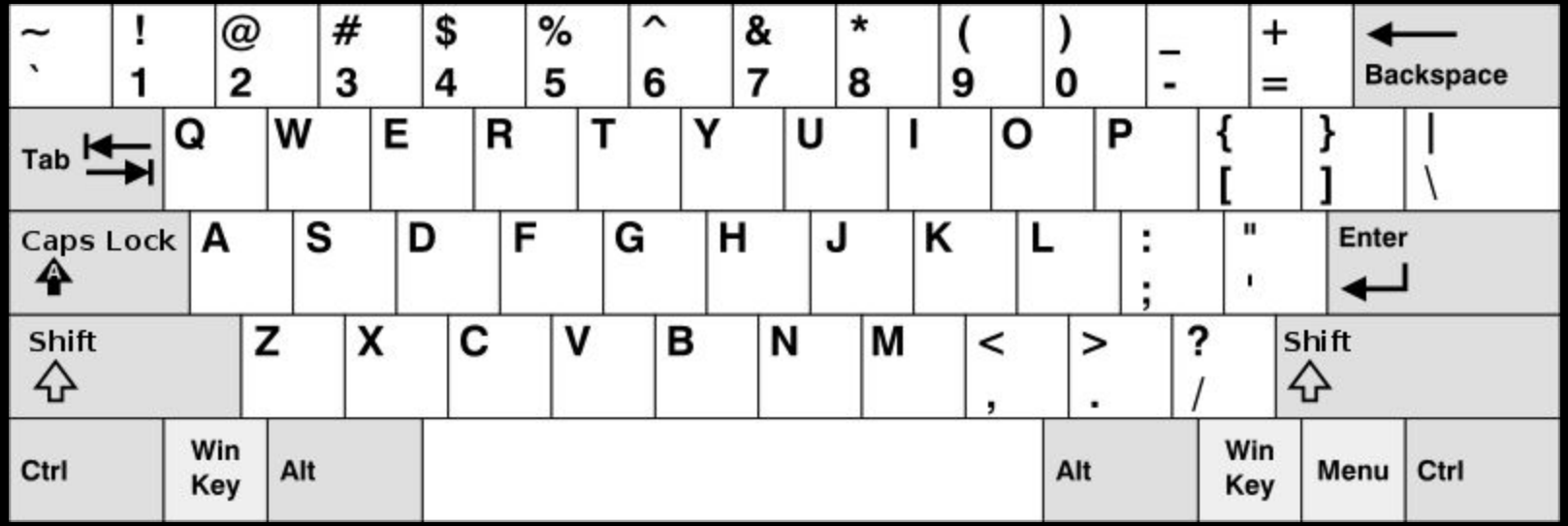
0	NUL	16	DLE	32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	17	DC1	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX	18	DC2	34	"	50	2	66	B	82	R	98	b	114	r
3	ETX	19	DC3	35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	20	DC4	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	21	NAK	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK	22	SYN	38	&	54	6	70	F	86	V	102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

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

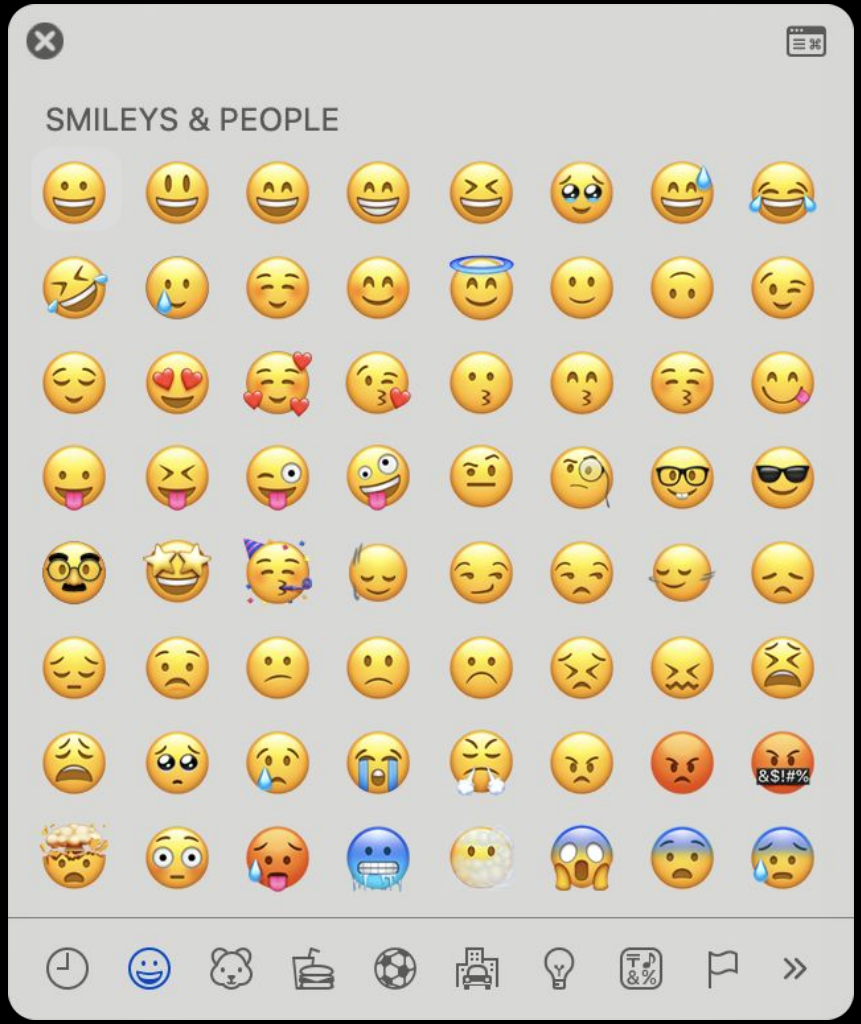
H	I	!
72	73	33

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




~ `
! 1
@ 2
# 3
$ 4
% 5
^ 6
& 7
* 8
(9
) 0
_ -
+ =
Backspace
Tab
Q
W
E
R
T
Y
U
I
O
P
{ [
}]
| \
Caps Lock
A
S
D
F
G
H
J
K
L
: ;
" '
Enter
Shift
Z
X
C
V
B
N
M
< ,
> .
? /
Shift
Ctrl
Win Key
Alt
Alt
Win Key
Menu
Ctrl


à á â ä æ ã å ā
1 2 3 4 5 6 7 8
a

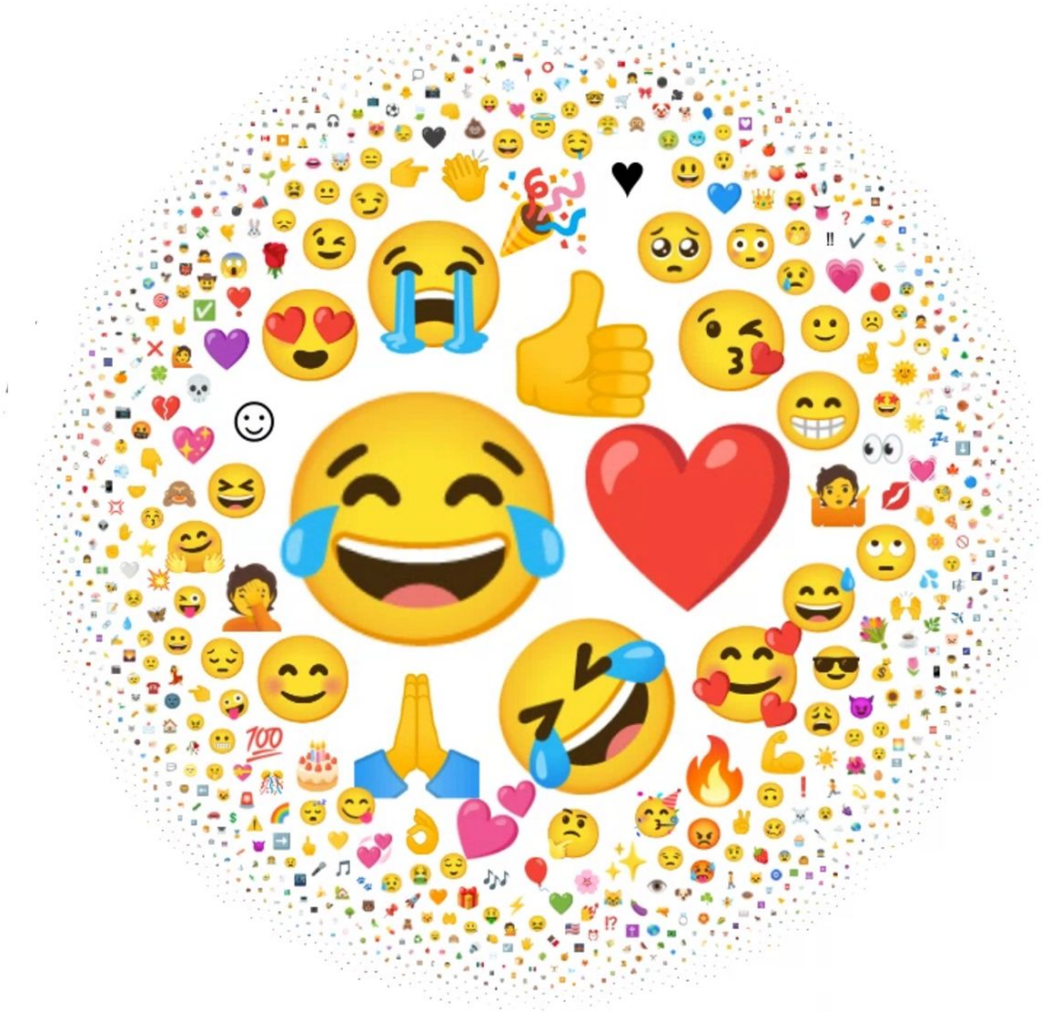

SMILEYS & PEOPLE

Unicode

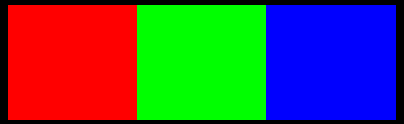
11110000100111111001100010000010

4036991106

U+1F602

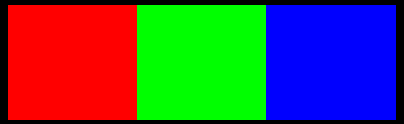


RGB



72 73 33


72
73
33



face-with-tears-of-joy_1f602.png

Search

face-with-tears-of-joy_1f602.png

Search

face-with-tears-of-joy_1f602.png

Search

```
print(“Hello World”)
```


01111111010001010100110001000110000000100000000100000001000000000000000000000000000000000000000000
00000000000000000000000000000001000000000111110000000000000010000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
00000000000001010000000000100000000000000000000000000000000000000000000000000000000000000000000000
00000000100000000000000000000000000000000000000000100000000000000001010000000000000010000000
00010101010100100010001001111001010100100010000111110110000010000001100011100000010001001110001110100
10001011111000000000000000000000000000000000000000000000000000000000000000000000000000010110000000000001110100000
00000000000000000000000000001001000101111110000000000000000000000000000000000000000000000000000000000
0000000001001000...01111111010001010100110001000110000000100000000100000001000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000011000000000011111000000000000000100000000000000000
00000001100000000001111000000000000000000000000000000000000000000000000000000000000000010000000000000000000000000
00000000000000000000000000000000000010100000110010000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000010000000000000011100000000000000011100000000010000000000000000011100000
00000000110010000000000000010000000000000000000000000000000010100000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000000000...00101111011011000110100101100010011000110010111001110011011011110
00101110001101100010000000101111011101010111001101110010001011110110110001101001011000100010111011110
00001110000011011001011111001101100011010000101101011011000110100101101110011101010111100001011010110
01110110111001110101001011110110110001101001011000100110001101011111011011100110111101101110011100110101
10100001100001011100100110010101100100001011100110000100100000010000001000001010100110101111101001110
01000101010001010100010001000101010001000010000000101000001000000010111101101100011010010110001000101111
11011110000011100000110110010111110011011000110100001011010110110001101001011011100111010101111000001011
01010110011101101110011101010010111101101100011001000010110101101100011010010110111001110101011110000010
10110101111000001110000011011000101101001101100011010...

Image Credit: BBC

Base Conversion

Denary	Binary	Hex
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Binary to Hex

0101101

010 1101

0010 1101

2 D

Hex to Binary

F92

F 9 2

1111 1001 0010

111110010010

Arithmetic

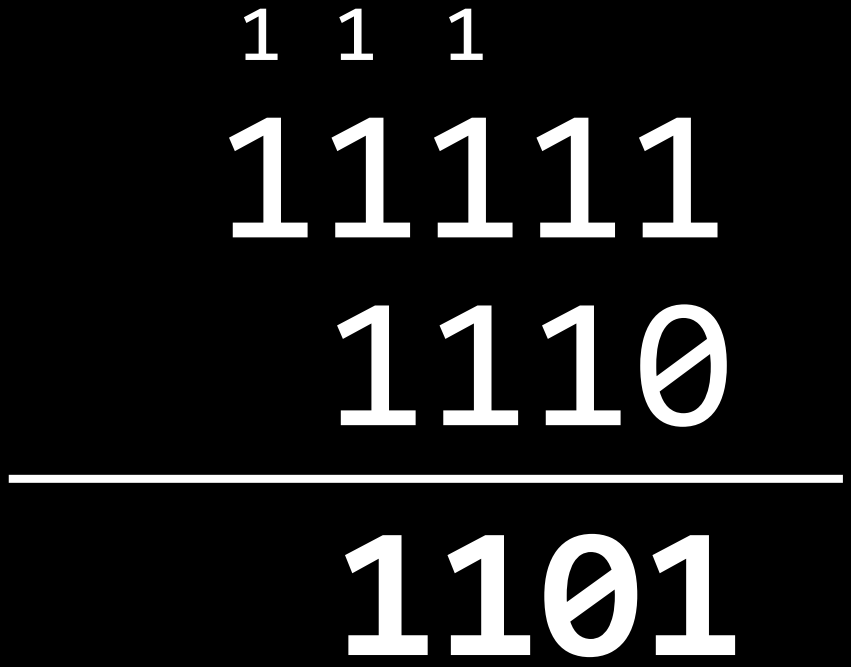
Addition

```
 11111
  1110
------
```

```
 11111
  1110
------
     1
```

```
  1
 11111
  1110
------
    01
```

```
  1 1
 11111
  1110
------
   101
```


1 1 1
11111
1110
1101

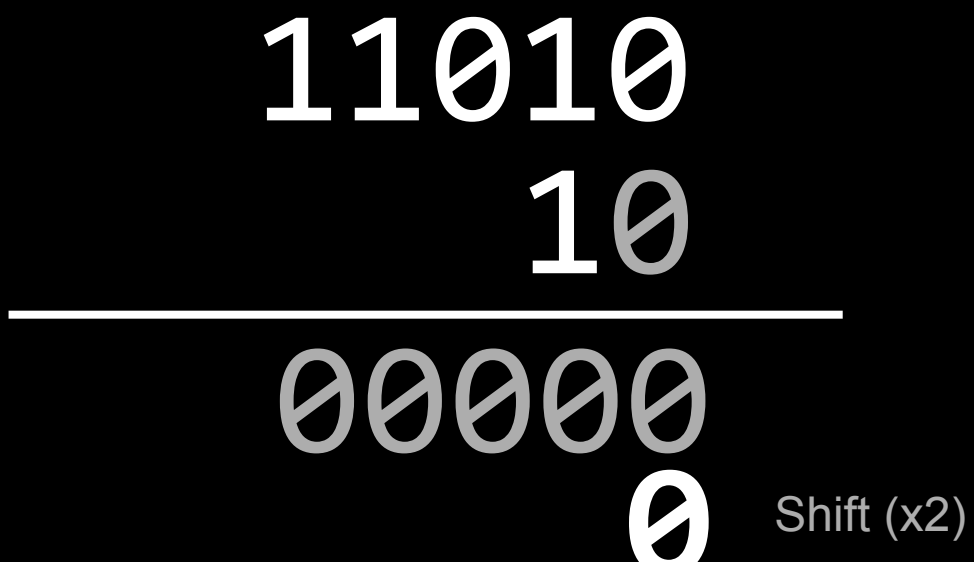
```
  1 1 1 1
  11111
   1110
-------
  01101
```

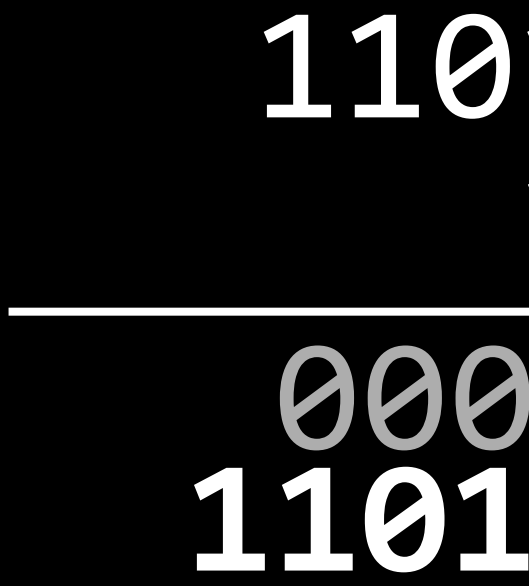
```
 11111
  1110
------
101101
```

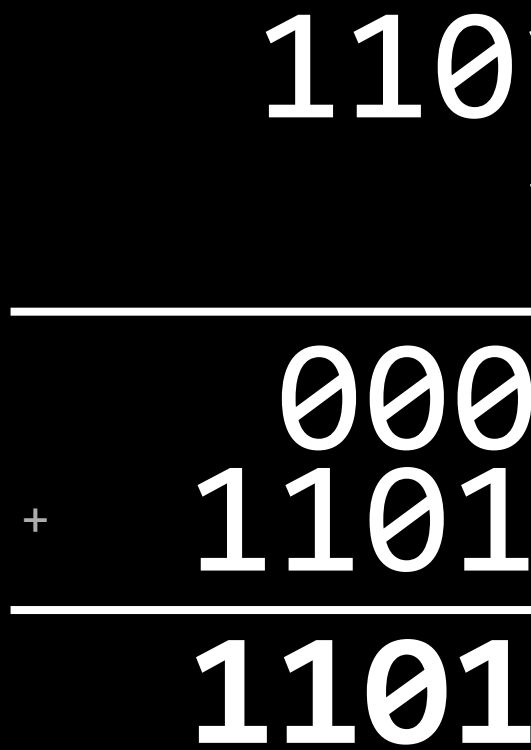
Multiplication

$$\frac{11010}{10}$$

```
  11010
     10
-------
  00000
```

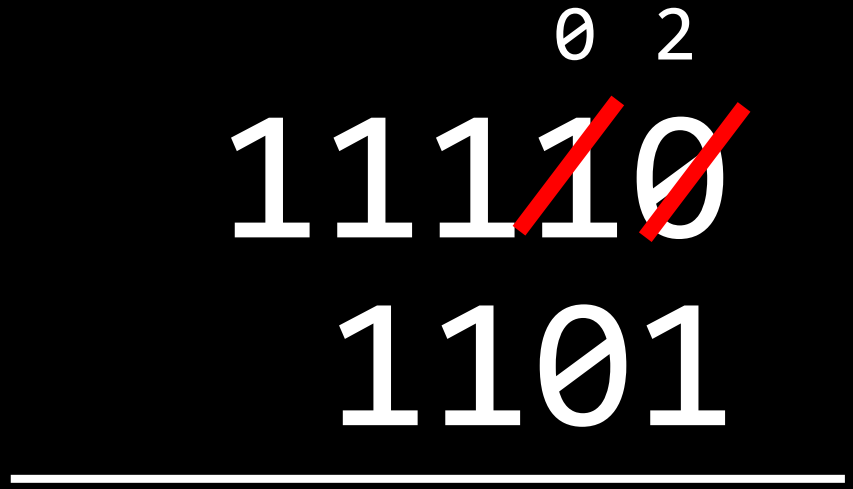

11010
10
00000
0
Shift (x2)

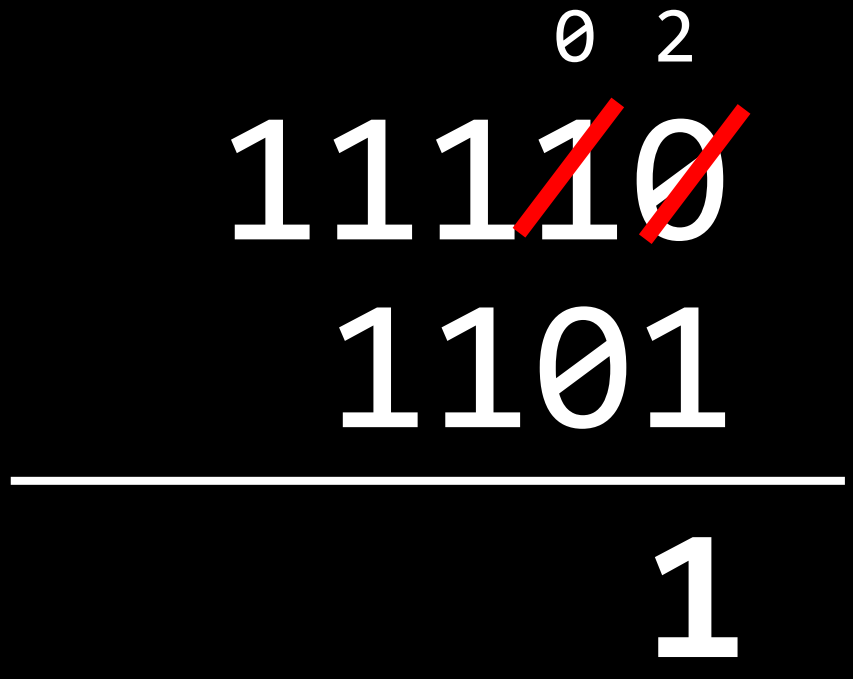

11010
10
00000
110100

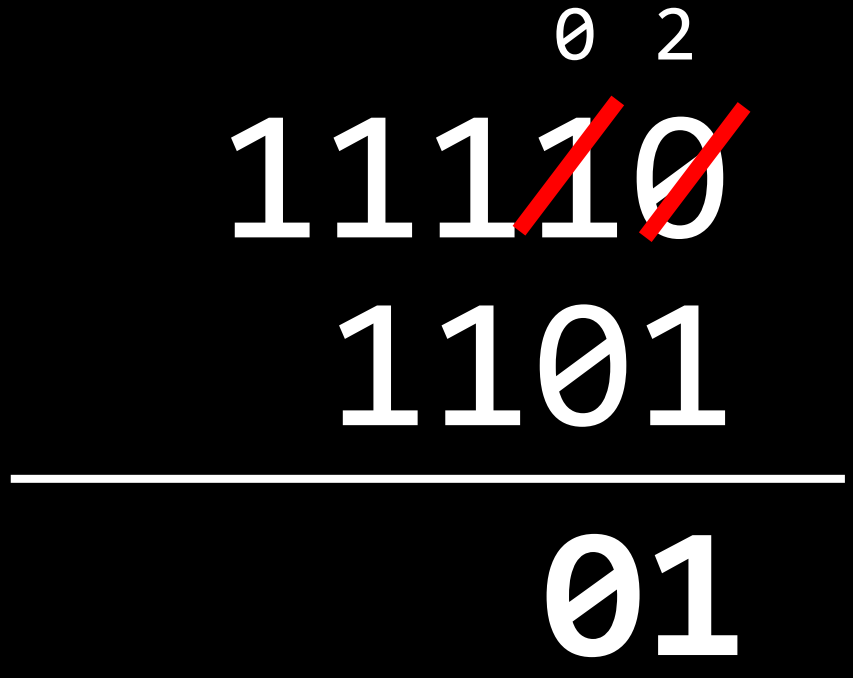

11010
10
00000
+ 110100
110100

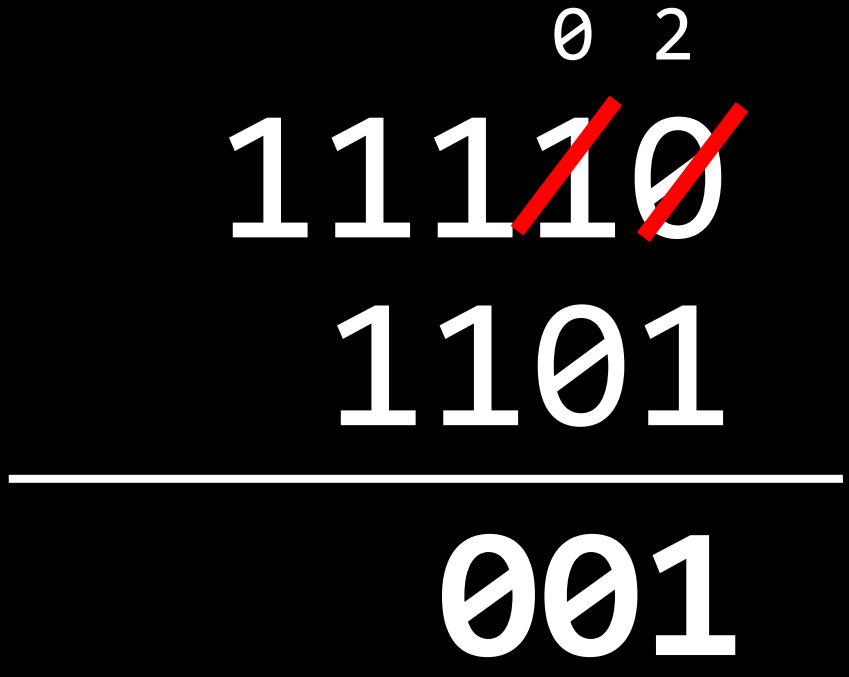
Subtraction

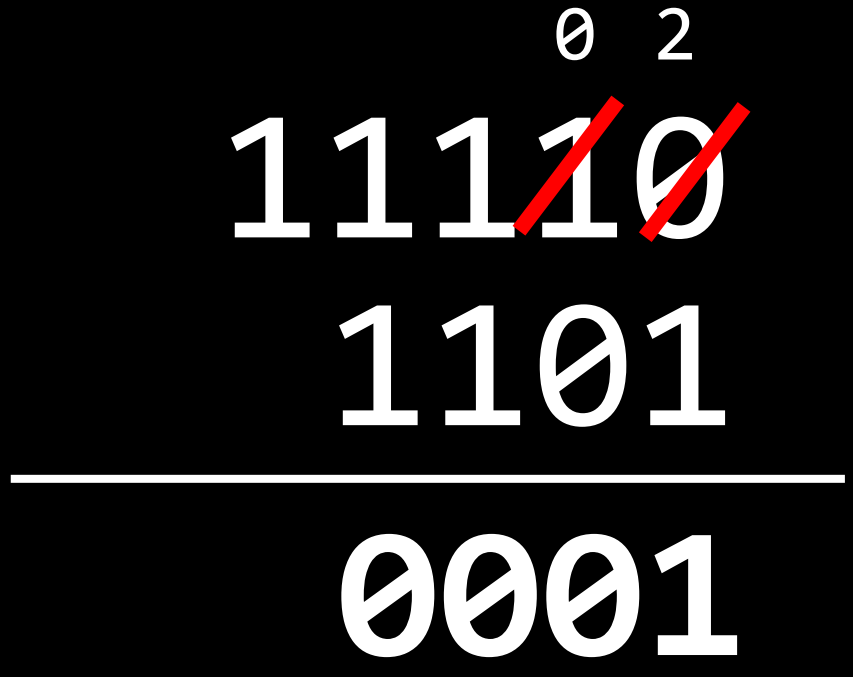
```
11110
 1101
-----
```

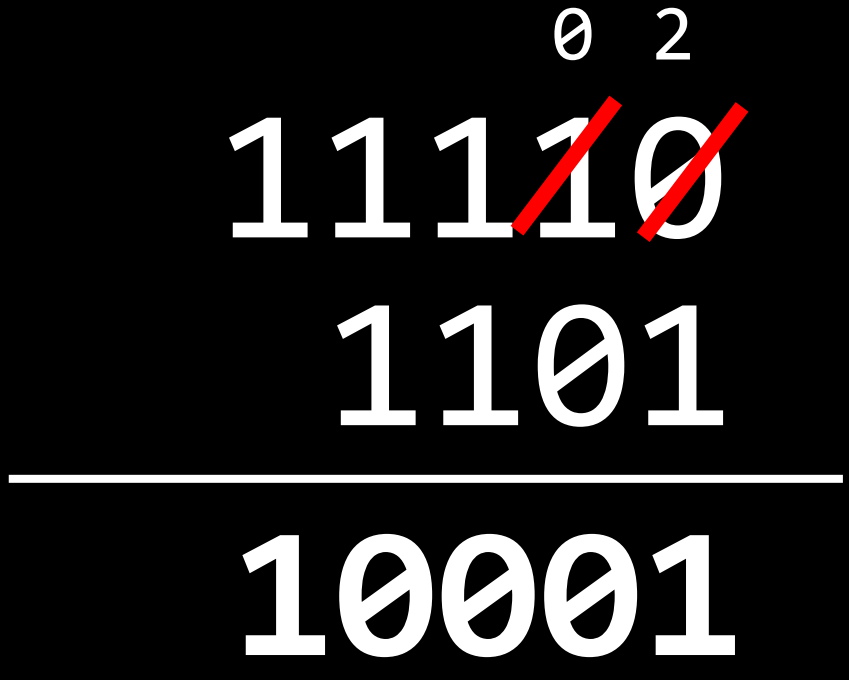

0 2
11110
1101


0 2
11110
1101
1


0 2
11110
1101
01

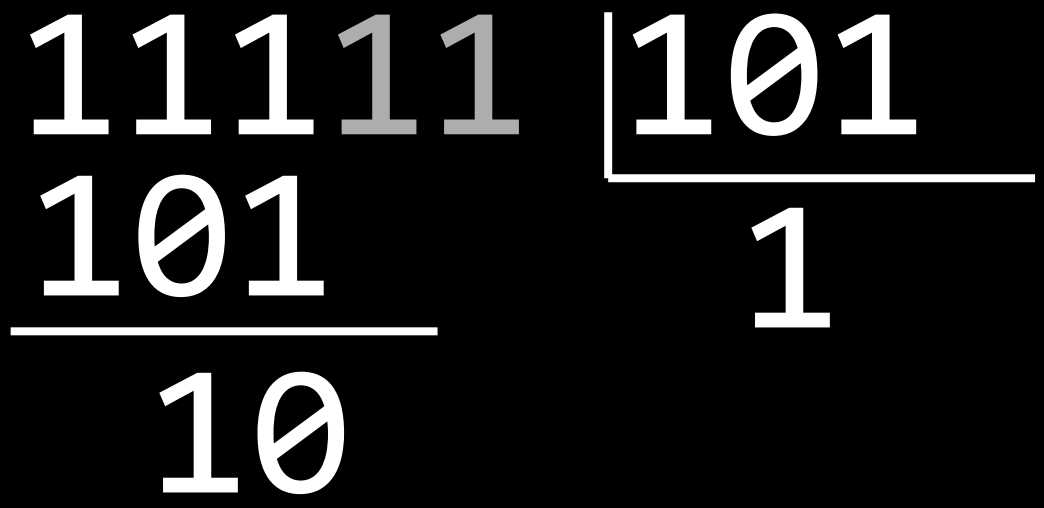

0 2
11110
1101
001

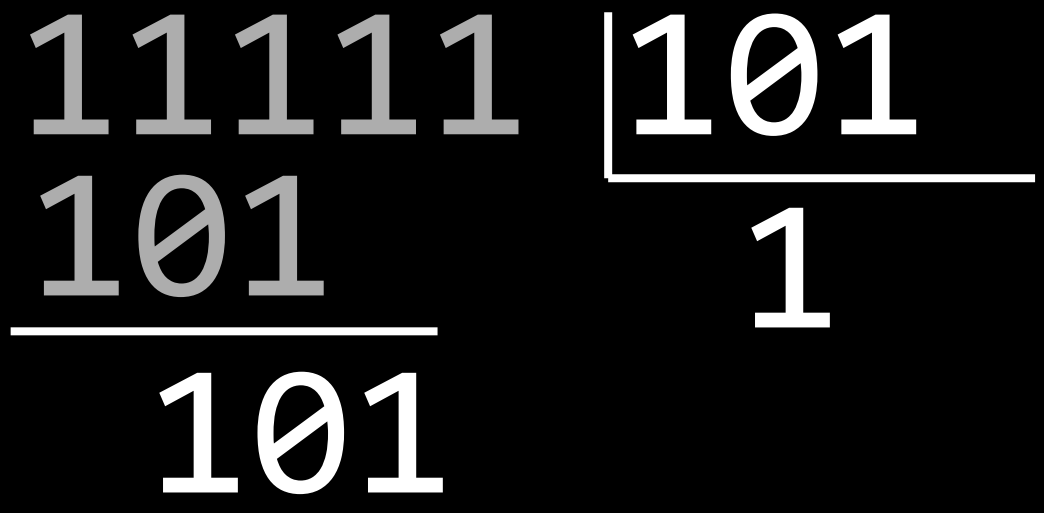

0 2
11110
1101
0001

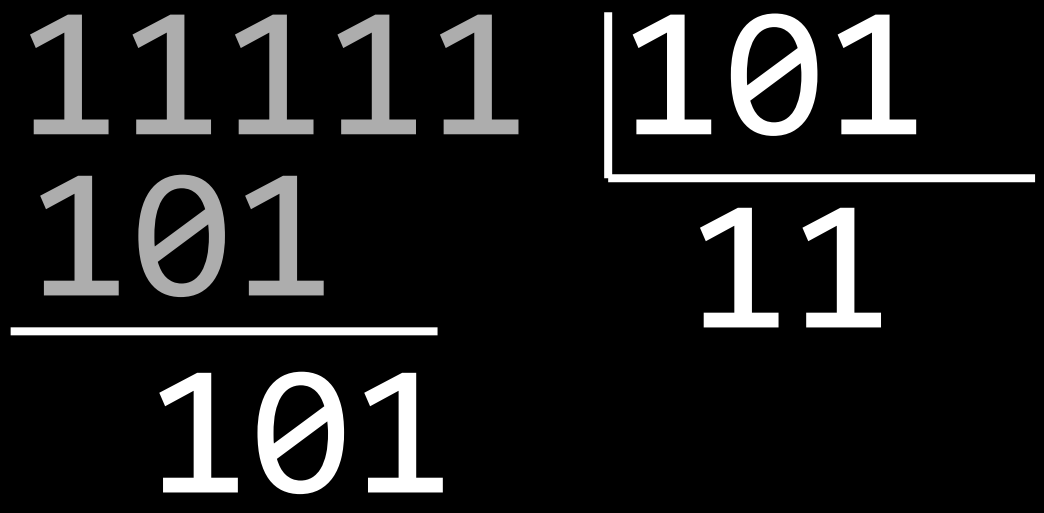

0 2
11110
1101
10001

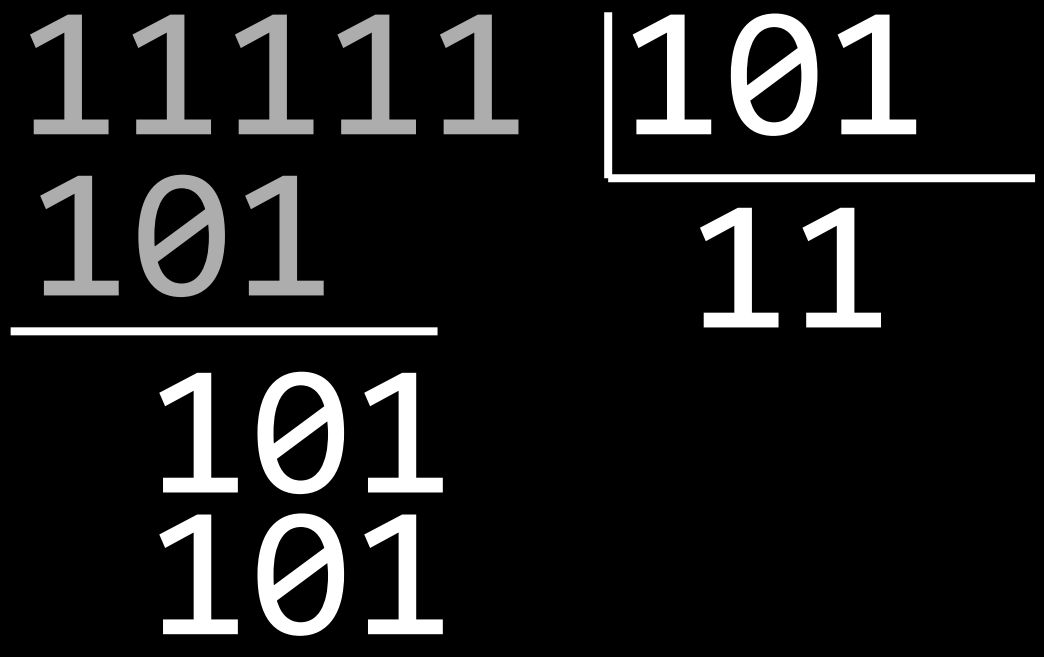
Division

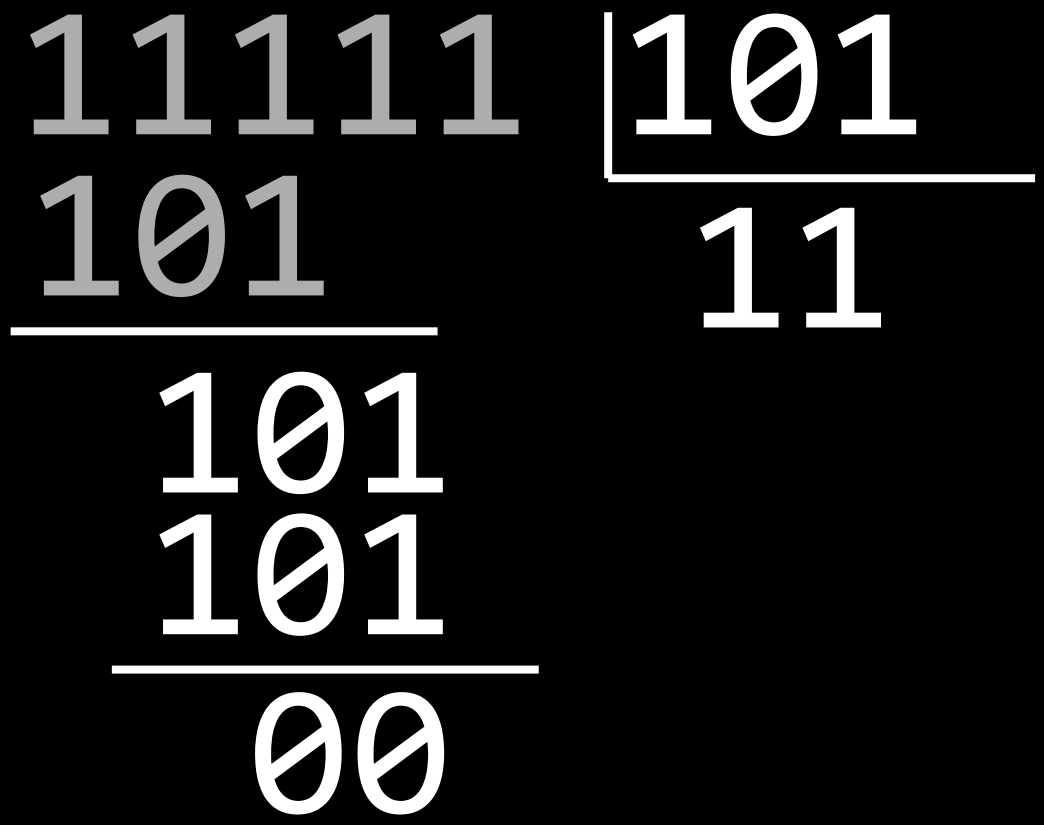

11111
101

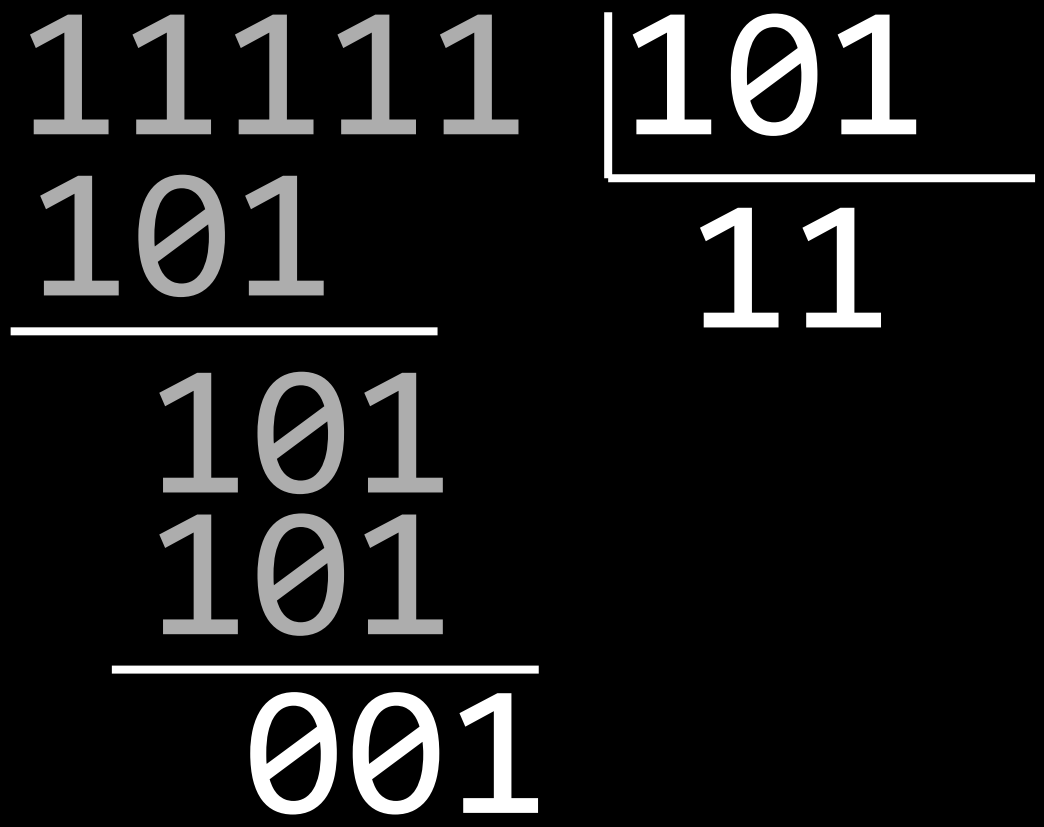

11111
101
101
10
101
1

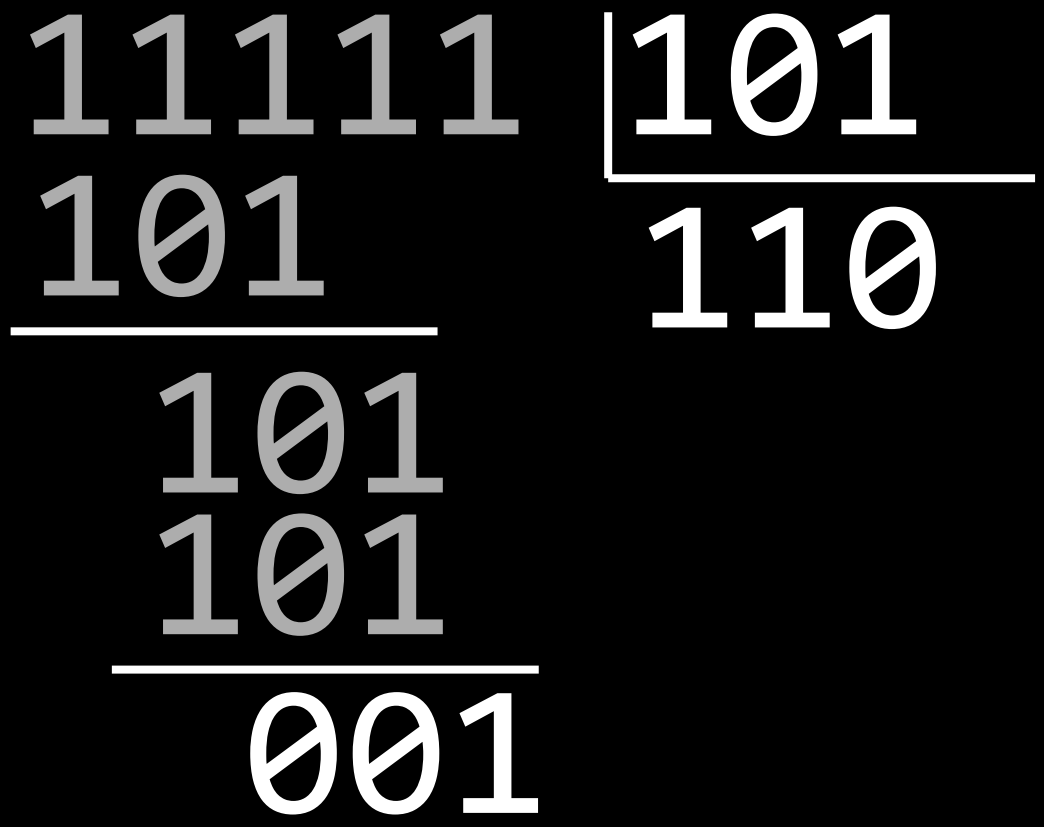

11111
101
101
101
101
1

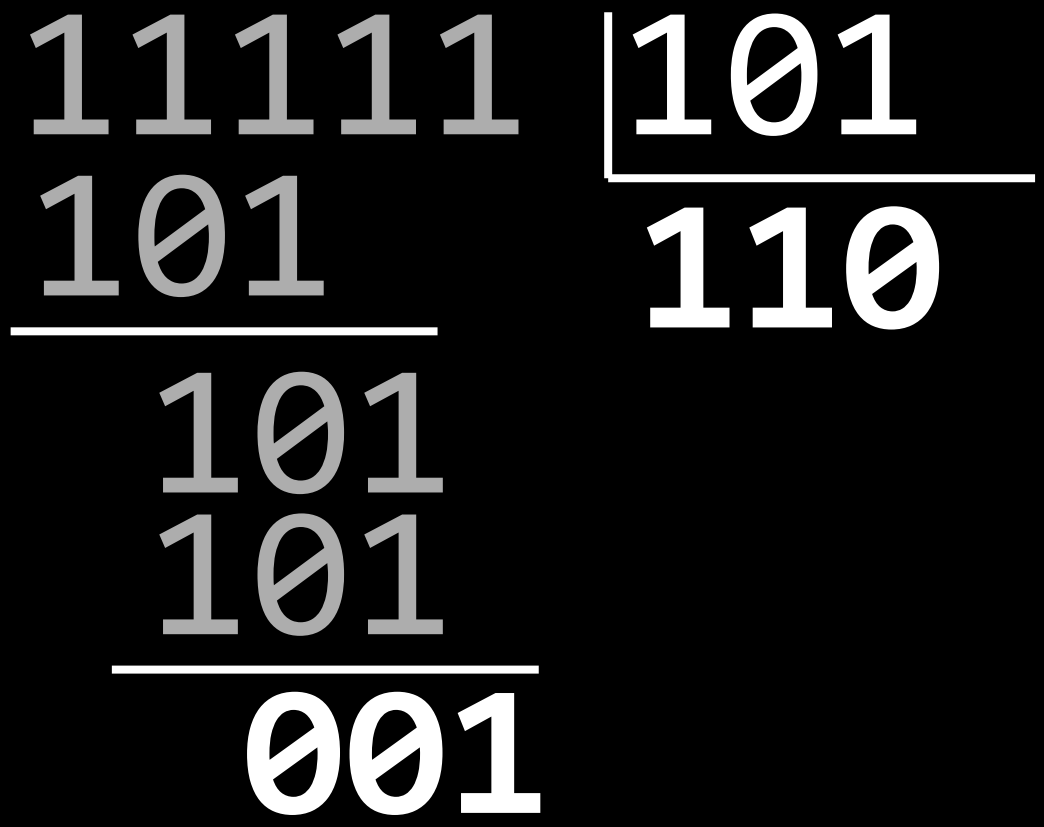

11111
101
101
101
101
11


11111
101
101
101
101
11


11111
101
101
101
101
00
101
11


11111
101
101
101
101
001
101
11


11111
101
101
101
101
001
101
110


11111
101
101
101
101
001
101
110

Bitwise Logical Operators

&

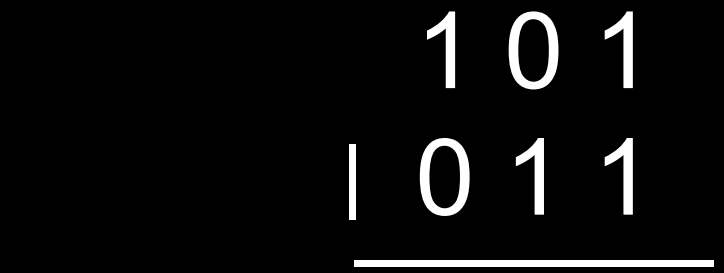
(AND)

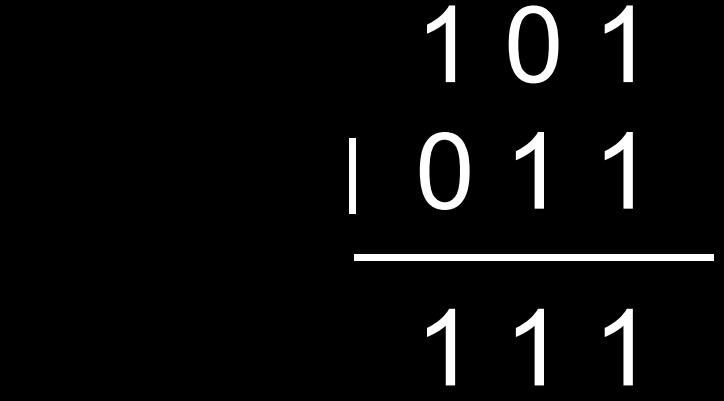
1 0 1

& 0 1 1

```
  1 0 1
& 0 1 1
-------
  0 0 1
```

(OR)


1 0 1
0 1 1


1 0 1
0 1 1
1 1 1

(XOR)

1 0 1

^ 0 1 1

```
  1 0 1
^ 0 1 1
-------
  1 1 0
```

<<

(left shift)

01011010

01011010

01011010100

10110100

>>

(right shift)


P


P


P

01011010

00101101010

00101101 0

00101101

References

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