HW 9: Signed Binary Arithmetic

For each of the <**X**, **Y**> pairs in the table below:

a) Convert **X** and **Y** → binary

b) Compute $\overset{\cdots}{\mathbf{X}}\mathbf{+}\mathbf{Y}$ (the 8-bit **sum**)

c) Compute $\overset{\cdots}{\bar{\mathbf{Y}}}$ (the 2's complement of **Y**)

d) Compute $\mathbf{X}\overset{\cdots}{\mathbf{-}}\mathbf{Y} \equiv \mathbf{X}\overset{\cdots}{\mathbf{+}}\overset{\cdots}{\bar{\mathbf{Y}}}$ (the 8-bit **difference**)

e) Indicate the signs of **X**, **Y**, $\overset{\cdots}{\mathbf{X}}\mathbf{+}\mathbf{Y}$, $\overset{\cdots}{\bar{\mathbf{Y}}}$, and $\mathbf{X}\overset{\cdots}{\mathbf{-}}\mathbf{Y}$

f) Convert $\overset{\cdots}{\mathbf{X}}\mathbf{+}\mathbf{Y}$, $\overset{\cdots}{\bar{\mathbf{Y}}}$, and $\mathbf{X}\overset{\cdots}{\mathbf{-}}\mathbf{Y}$ → hexadecimal

g) Indicate condition flag (**z**, **n**, **c**, **v**) values for $\overset{\cdots}{\mathbf{X}}\mathbf{+}\mathbf{Y}$, $\mathbf{X}\overset{\cdots}{\mathbf{-}}\mathbf{Y}$

h) Which (if either) of $\overset{\cdots}{\mathbf{X}}\mathbf{+}\mathbf{Y}$ and $\mathbf{X}\overset{\cdots}{\mathbf{-}}\mathbf{Y}$ → is honest?

Where <**X**, **Y**> =

1) <0x**4F**, 0x**6D**>
2) <0x**B3**, 0x**17**>
3) <0x**A3**, 0x**95**>
4) <0x**6E**, 0x**3A**>

Signed Arithmetic Example X1

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			

Signed Arithmetic: X1 a)

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			
10001100	01101111			

Signed Arithmetic: X1 b)

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			
10001100	01101111	10001100 01101111 011111011		

Signed Arithmetic: X1 c)

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			
10001100	01101111	10001100 01101111 011111011	01101111 10010000 00000001 10010001	

Signed Arithmetic: X1 d)

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			
10001100	01101111	10001100 01101111 011111011	01101111 10010000 00000001 10010001	10001100 10010001 100011101

Signed Arithmetic: X1 e)

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			
10001100	01101111	10001100 01101111 011111011	01101111 10010000 00000001 10010001	10001100 10010001 100011101

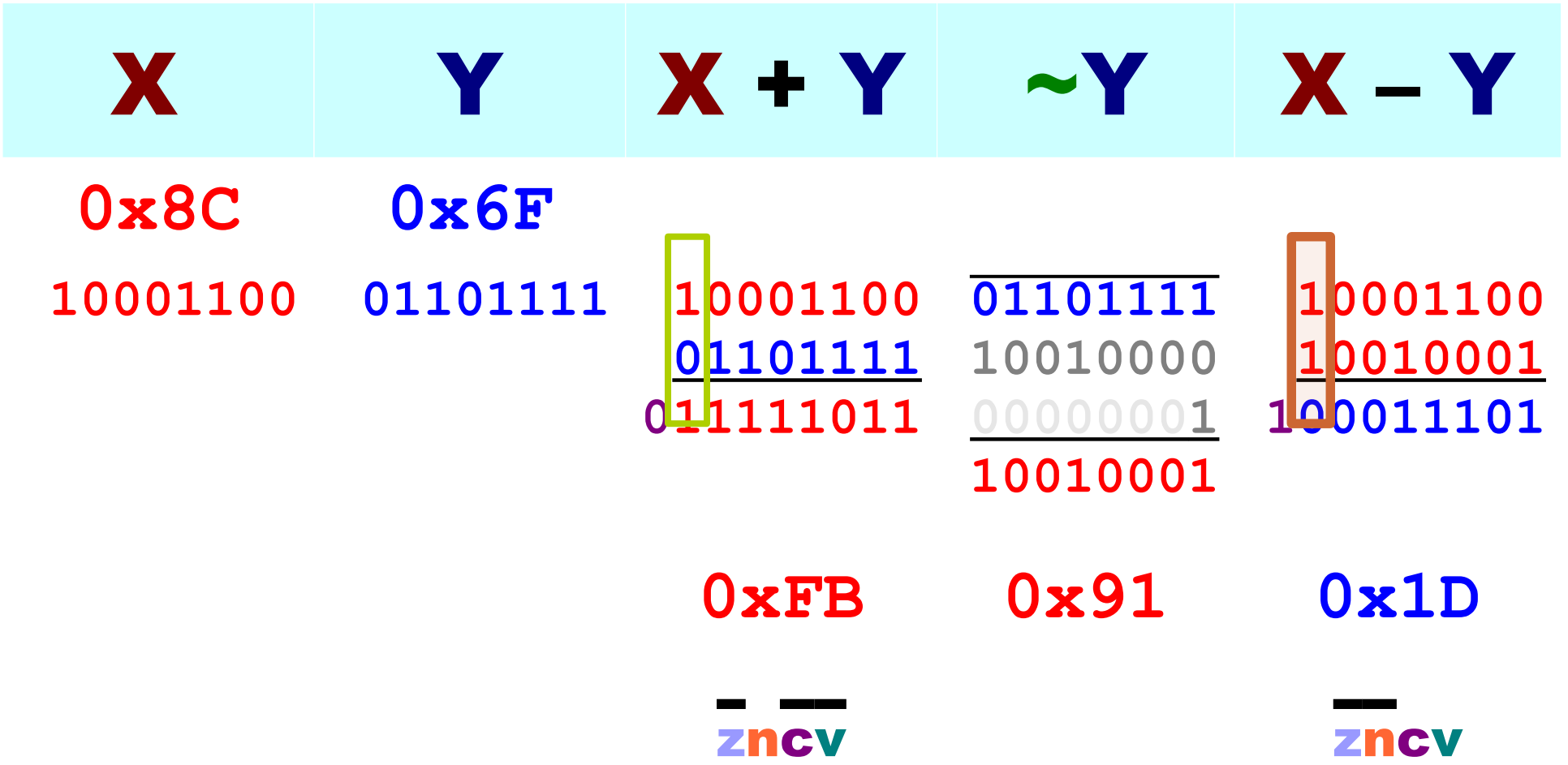
Signed Arithmetic: X1 f)

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			
10001100	01101111	10001100 01101111 011111011 0xFB	01101111 10010000 00000001 10010001 0x91	10001100 10010001 100011101 0x1D

Signed Arithmetic: X1

X	Y	X + Y	~Y	X – Y
0x8C	0x6F			
10001100	01101111	10001100 01101111 011111011 0xFB	01101111 10010000 00000001 10010001 0x91	10001100 10010001 100011101 0x1D
		no oVerflow		oVerflow

Signed Arithmetic: X1 g)

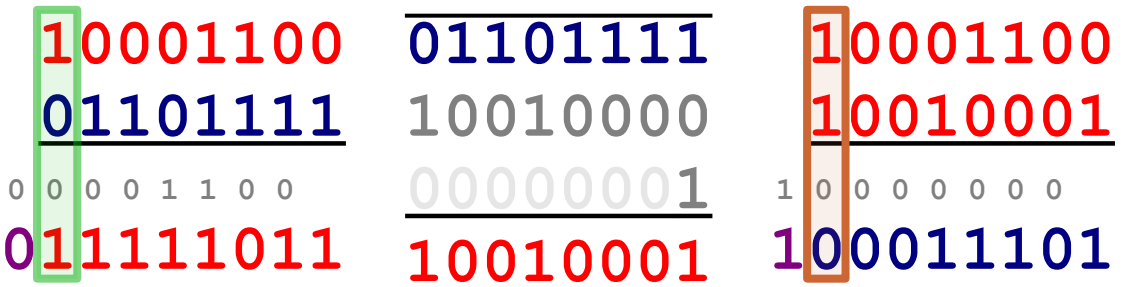


Signed Arithmetic: X1 h)

X	Y	X + Y	~Y	X – Y
0x8C	0x6F	0xFB	0x91	0x1D
10001100	01101111	10001100 01101111 011111011	01101111 10010000 00000001 10010001	10001100 10010001 100011101
		zncv		zncv
		honest		deceptive

Signed Arithmetic: X1 i)

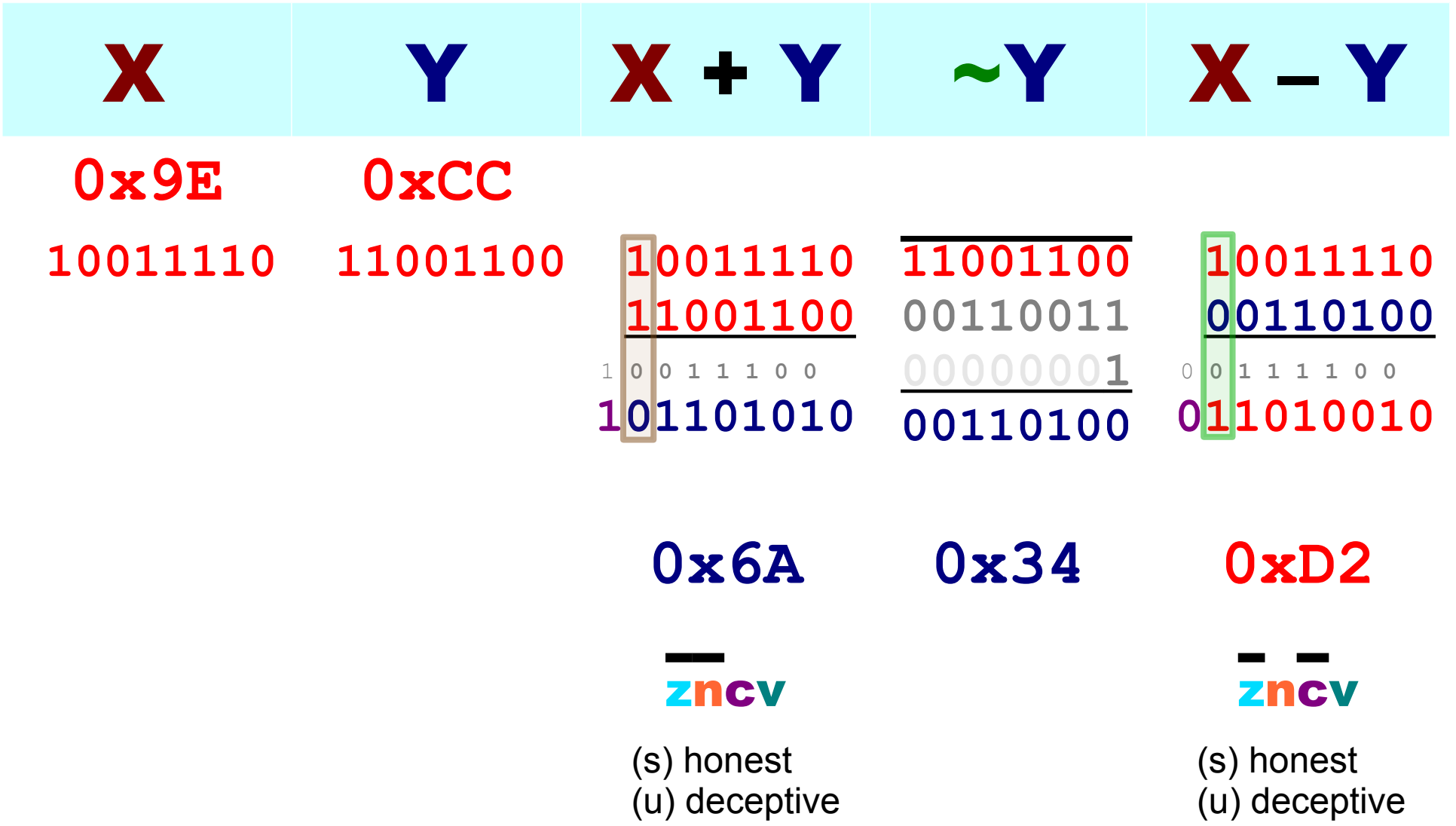
X	Y	X + Y	~Y	X – Y
0x8C	0x6F	0xFB	0x91	0x1D
10001100	01101111	011111011	10010001	100011101
		zncv		zncv
		(s) honest (u) honest		(s) deceptive (u) honest



Signed Arithmetic: X2 i)

X	Y	X + Y	~Y	X – Y
0x54	0xF3			
01010100	11110011	01010100 11110011 1 1 1 1 0 0 0 0 101000111	11110011 00001100 00000001 00001101	01010100 00001101 0 0 0 1 1 1 0 0 001100001
		0x47	0x0D	0x61
		zncv		zncv
		(s) honest (u) deceptive		(s) honest (u) deceptive

Signed Arithmetic: X3 i)



Signed Arithmetic Example: X4

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			

Signed Arithmetic: X4 a)

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010			

Signed Arithmetic: X4 b)

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010	01011010 01011010		
		0 1 0 1 1 0 1 0 010110100		

Signed Arithmetic: X4 c)

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010	01011010	01011010	
		01011010	10100101	
		01011010	00000001	
		010110100	10100110	

Signed Arithmetic: X4 d)

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010	01011010	01011010	01011010
		01011010	10100101	10100110
		0 1 0 1 1 0 1 0	00000001	1 1 1 1 1 1 1 0
		010110100	10100110	111101000

Signed Arithmetic: X4 e)

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010	01011010 01011010 0 1 0 1 1 0 1 0 010110100	01011010 10100101 00000001 10100110	01011010 10100110 1 1 1 1 1 1 1 0 111101000

Signed Arithmetic: X4 f)

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010	01011010 01011010 0 1 0 1 1 0 1 0 010110100	01011010 10100101 00000001 10100110	01011010 10100110 1 1 1 1 1 1 1 0 111101000
		0xB4	0xA6	0x00

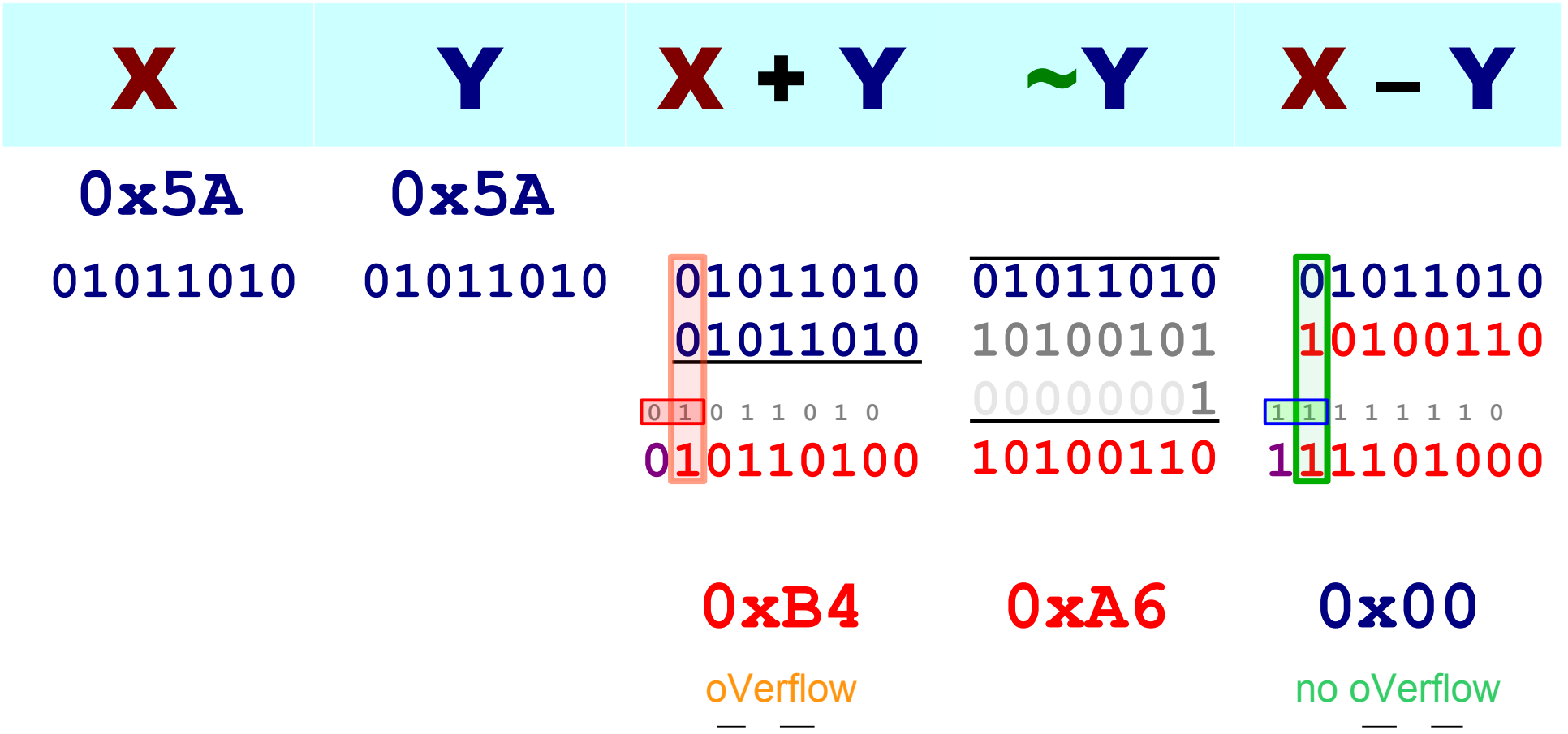
Signed Arithmetic: X4

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010	01011010 01011010 0 1 0 1 1 0 1 0 010110100	01011010 10100101 00000001 10100110	01011010 10100110 1 1 1 1 1 1 1 0 11101000
		0xB4	0xA6	0x00
		oVerflow		no oVerflow

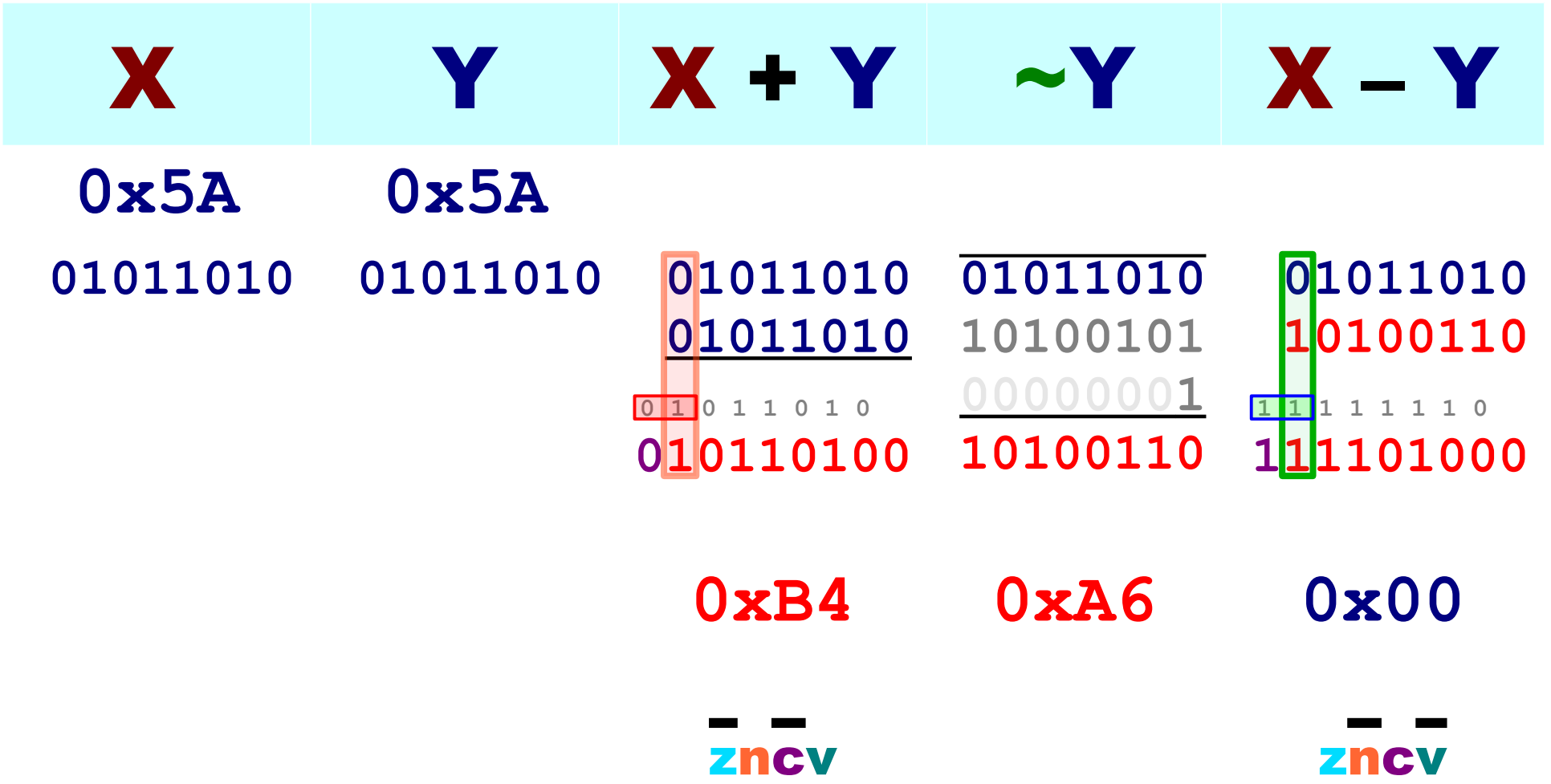
Signed Arithmetic: X4

X	Y	X + Y	~Y	X – Y
0x5A	0x5A			
01011010	01011010	01011010 01011010 0 1 0 1 1 0 1 0 010110100	01011010 10100101 00000001 10100110	01011010 10100110 1 1 1 1 1 1 1 0 111101000
		0xB4	0xA6	0x00
		oVerflow		no oVerflow

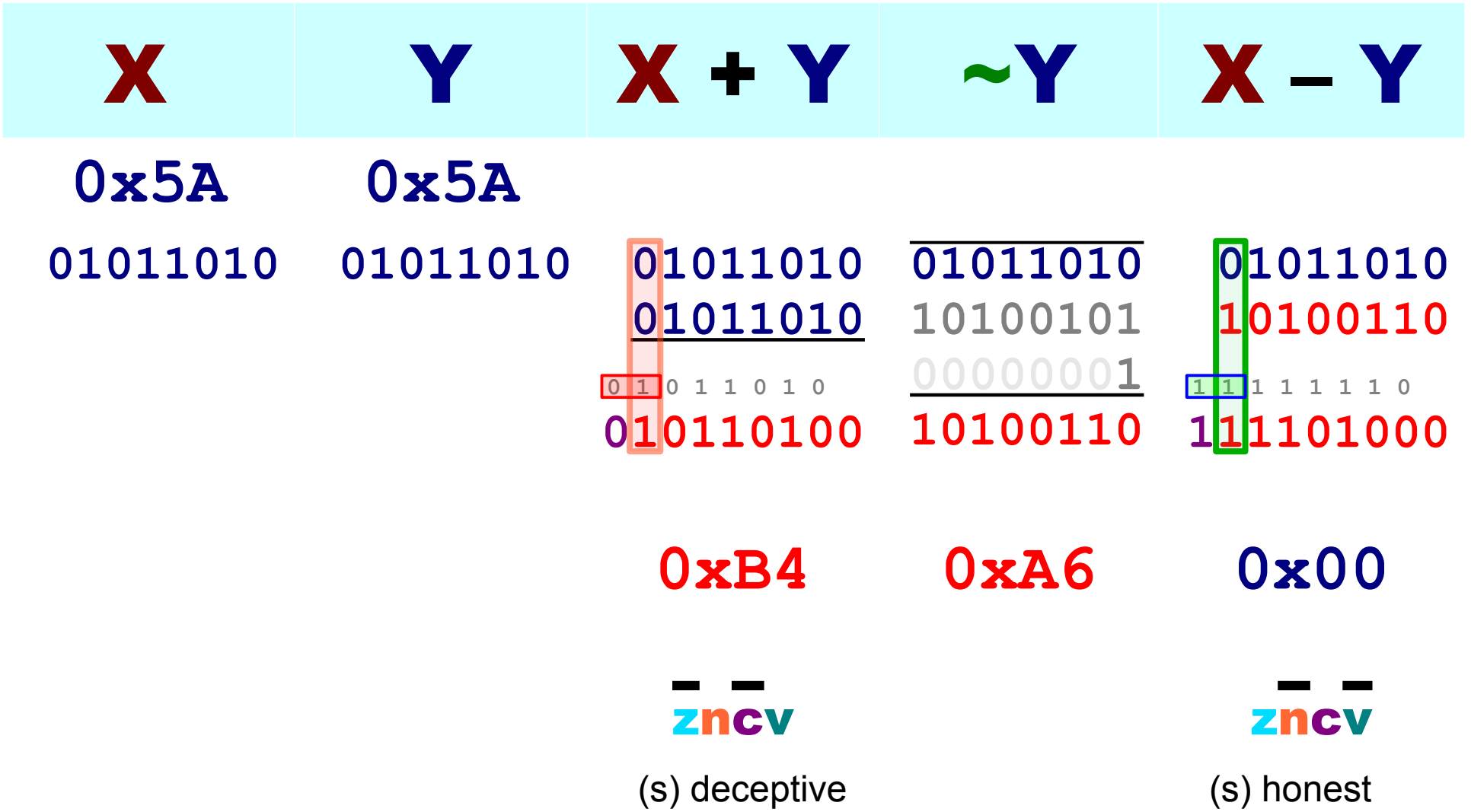
Signed Arithmetic: X4



Signed Arithmetic: X4 g)



Signed Arithmetic: X4 h)



Signed Arithmetic: X4 i)