*Mathematics for Computer Science*
6.042J/18.062J

# Digital Logic



## Adding in binary

carry: 1 1 1

39 is 100111
28 is 011100
1000011

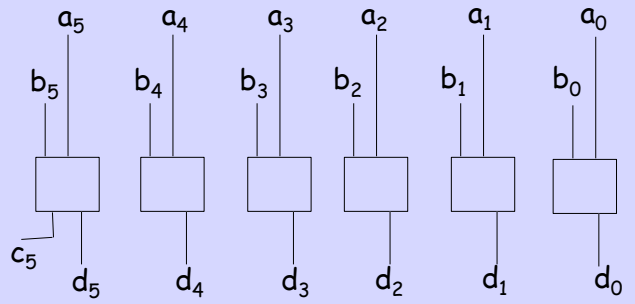


## Adding in binary

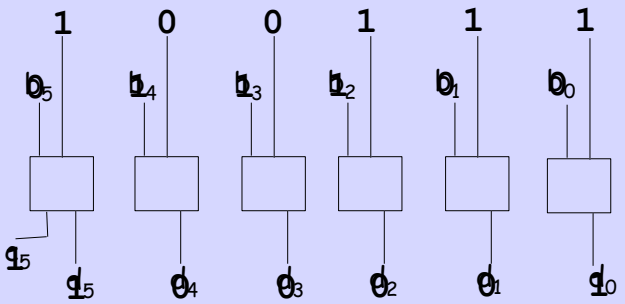
39 is 100111
28 is 011100
sum = 67 is 1000011



## Binary addition circuit

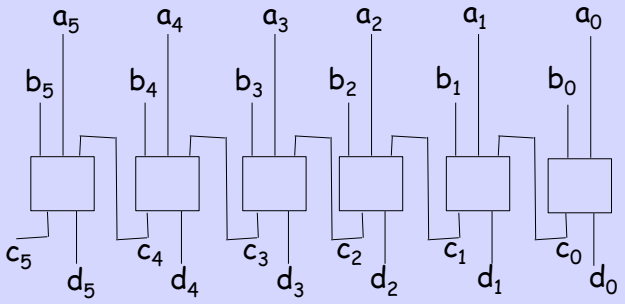


## Binary addition circuit





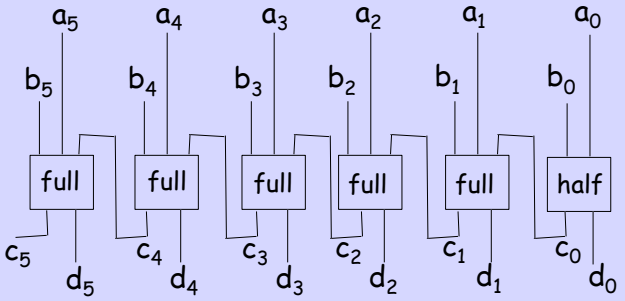

## Binary addition circuit




"ripple carry"



## Binary addition circuit



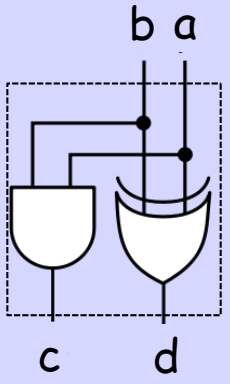

"ripple carry"



## half Adder

d ::= a XOR b

c ::= a AND b



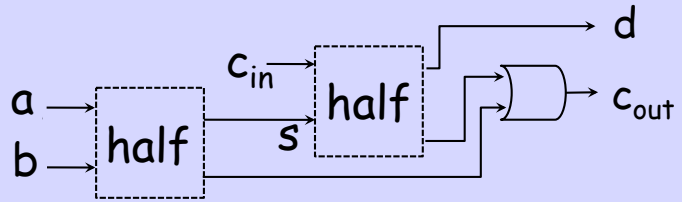

from http://en.wikipedia.org/wiki/Adder_(electronics)

# full Adder

$s ::= a \text{ XOR } b$

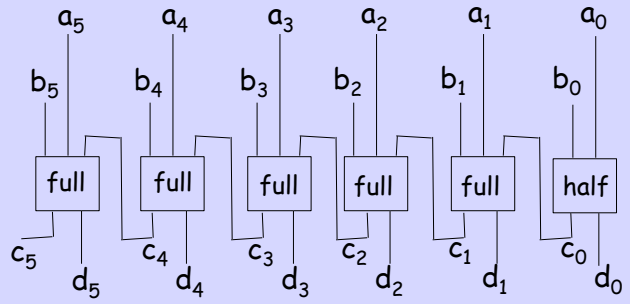
$d ::= c_{in} \text{ XOR } s$

$c_{out} ::= (c_{in} \text{ AND } s) \text{ OR } (a \text{ AND } b)$






# Binary addition circuit




"ripple carry"



# Ripple Carry formulas

$d_0 ::= a_0 \text{ XOR } b_0$

$c_0 ::= a_0 \text{ AND } b_0$

$s_i ::= a_i \text{ XOR } b_i$

$d_i ::= c_{i-1} \text{ XOR } s_i$

$c_i ::= (c_{i-1} \text{ AND } s_i) \text{ OR } (a_i \text{ AND } b_i)$