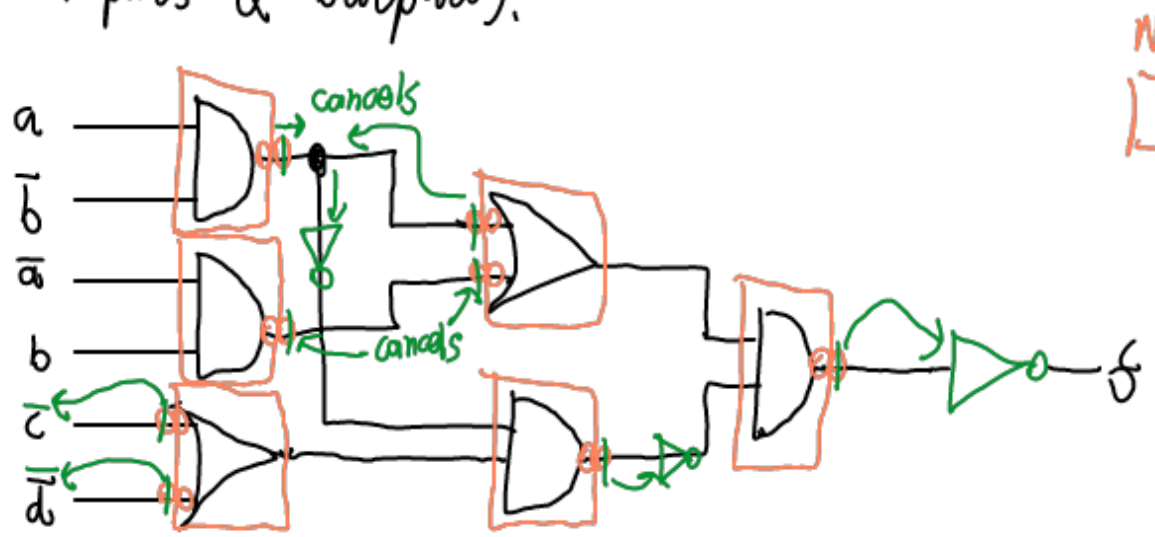
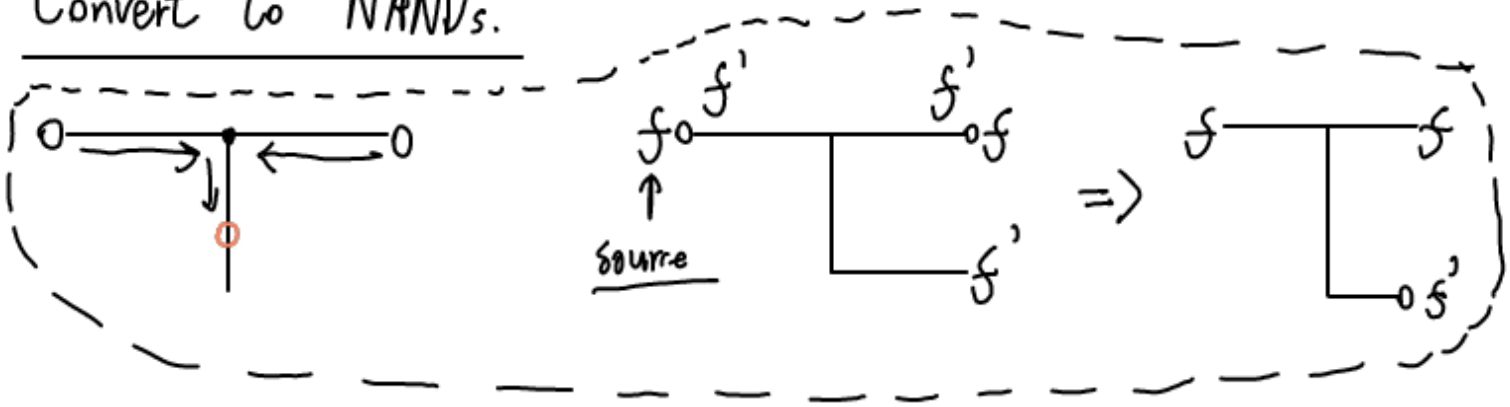
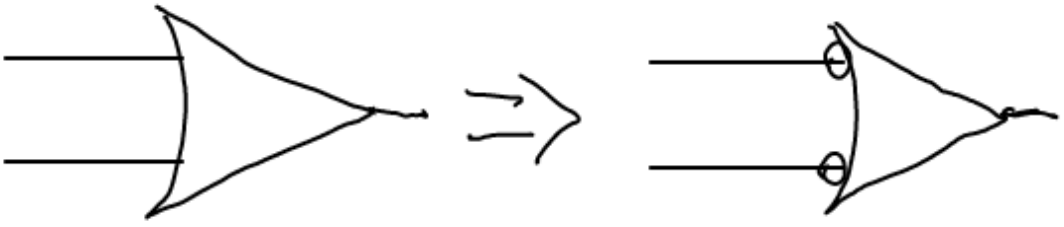
Multilevel NAND / NOR conversion.

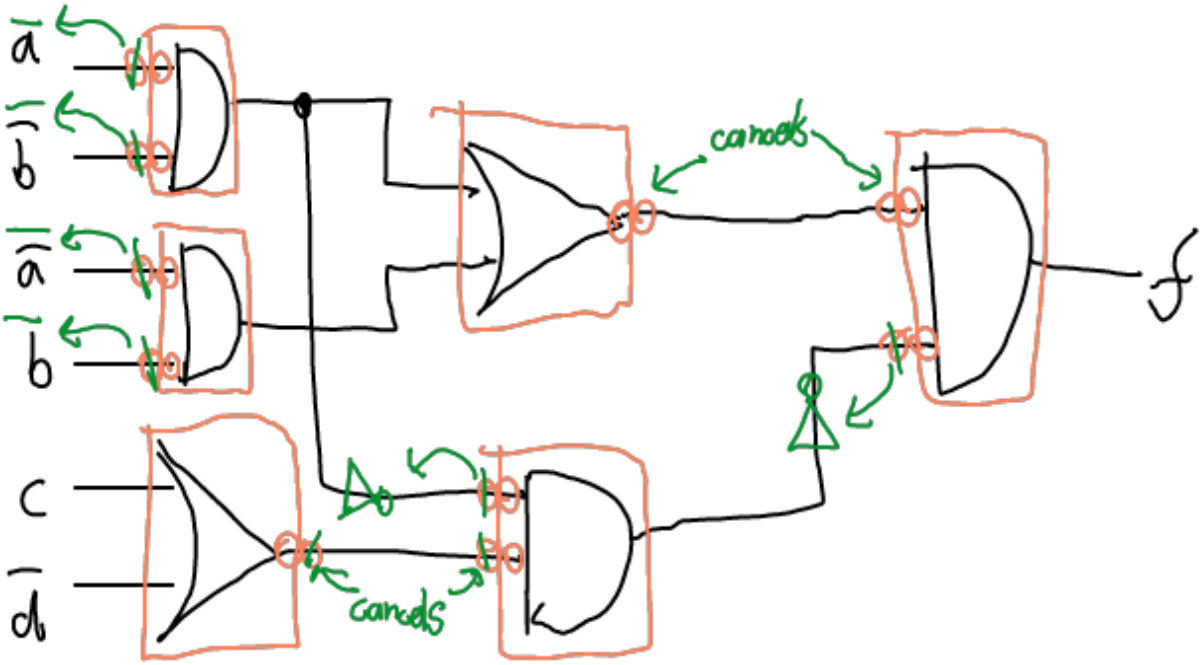
* Up to now, we have seen mostly 2-level circuits, but many circuits are multileveled. (≥3 levels of logic between inputs & outputs).



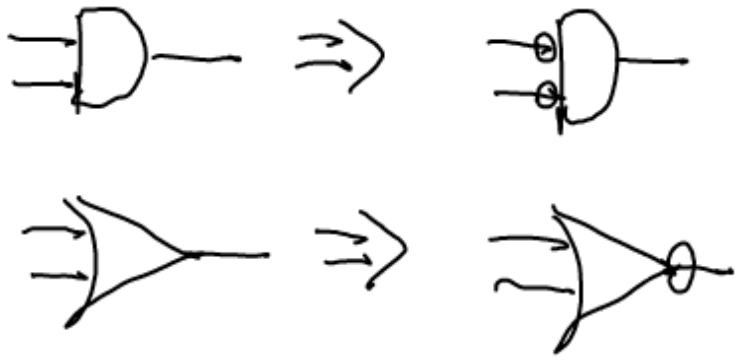
Convert to NANDs.





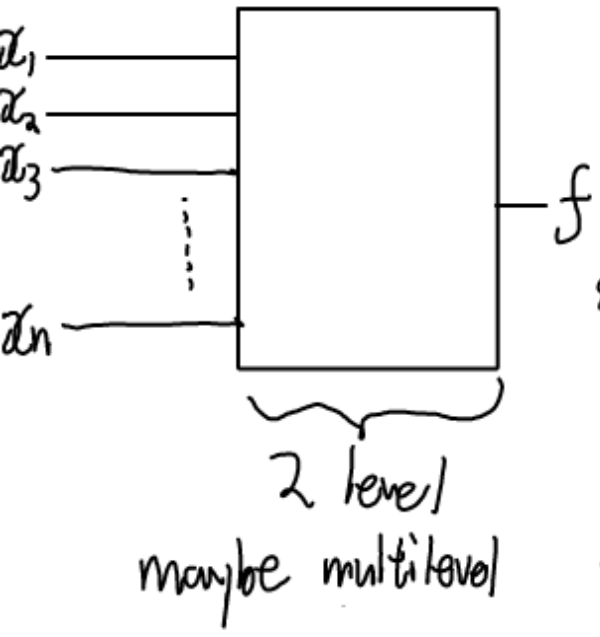


Convert to NORs:

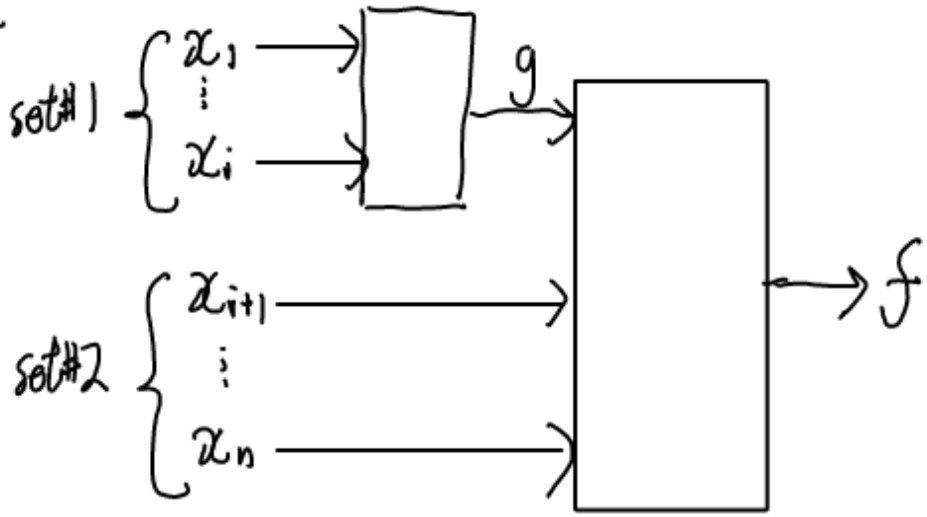


Factoring

* Maybe a 2-level circuit is large/costly. So, perhaps we can try to make a multilevel circuit instead.
* Lots of possible ways, so we will consider just one way.
* consider a function $f = f(x_1, x_2, x_3, \ldots, x_n)$



* say you split the input into 2 disjoint sets.



$$f = f(x_1, \cdots, x_n)$$

$$= f(g(x_1, \cdots, x_i), x_{i+1}, \cdots, x_n)$$

Try to find a minimum SOP.

dc \ ba	00	01	11	10
00	1	0	0	0
01	1	1	1	1
11	1	0	0	0
10	0	1	1	1

e=0

dc \ ba	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	0	0
10	1	1	1	1

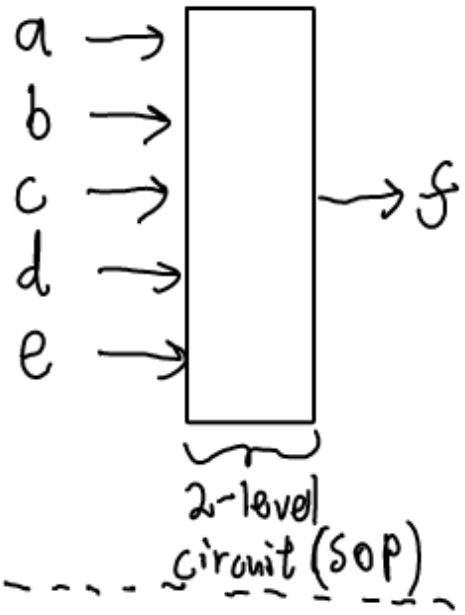
e=1

$c\bar{d}$, $\bar{a}\bar{b}\bar{d}\bar{e}$, $\bar{a}\bar{b}c\bar{e}$, $a\bar{c}d$, $b\bar{c}d$

$$f = c\bar{d} + \bar{c}de + b\bar{c}d + a\bar{c}d + \bar{a}\bar{b}\bar{d}\bar{e} + \bar{a}\bar{b}c\bar{e}$$

$$\bar{a}\bar{b}\bar{e}(\bar{d} + c)$$

6 AND
1 OR
19 inputs (AND)
6 inputs (OR)
32 Cost

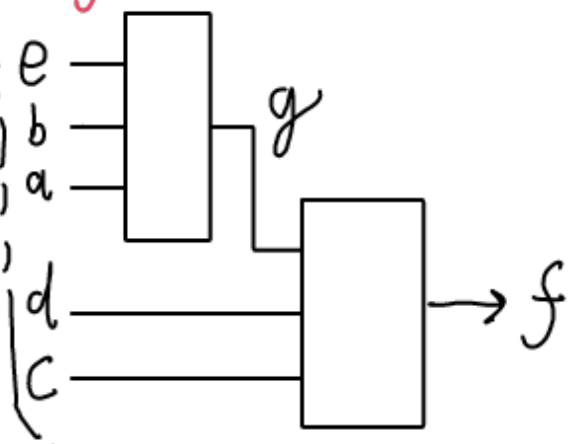


consider splitting inputs into sets $\{a, b, c\}, \{dc\}$.

dc \ eba	000	001	010	011	100	101	110	111
00	1	0	0	0	0	0	0	0
01	1	1	1	1	1	1	1	1
11	1	0	0	0	0	0	0	0
10	0	1	1	1	1	1	1	1
g:	0	1	1	1	1	1	1	1

e	b	a	g
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

dc \ g	0	1
00	1	0
01	1	1
11	1	0
10	0	1



$$f = \bar{g}d\bar{c} + \bar{g}c + \bar{d}c + gd\bar{c}$$