1. Circuit diagram

a. identifying same suit circuit (same_suit)

$i_0(S)$
$i_1(S)$ — xor

$i_3(4)$
$i_4(4)$ — xor

nor, nor, and

— if 5 cards are same suit or not
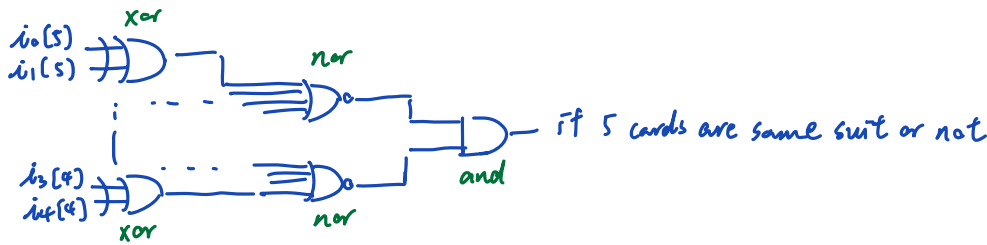
b. identifying if two numbers have same value (same_value)

$x(0)$
$y(0)$ — xor

$x(1)$
$y(1)$

$x(2)$
$y(2)$

$x(3)$
$y(3)$
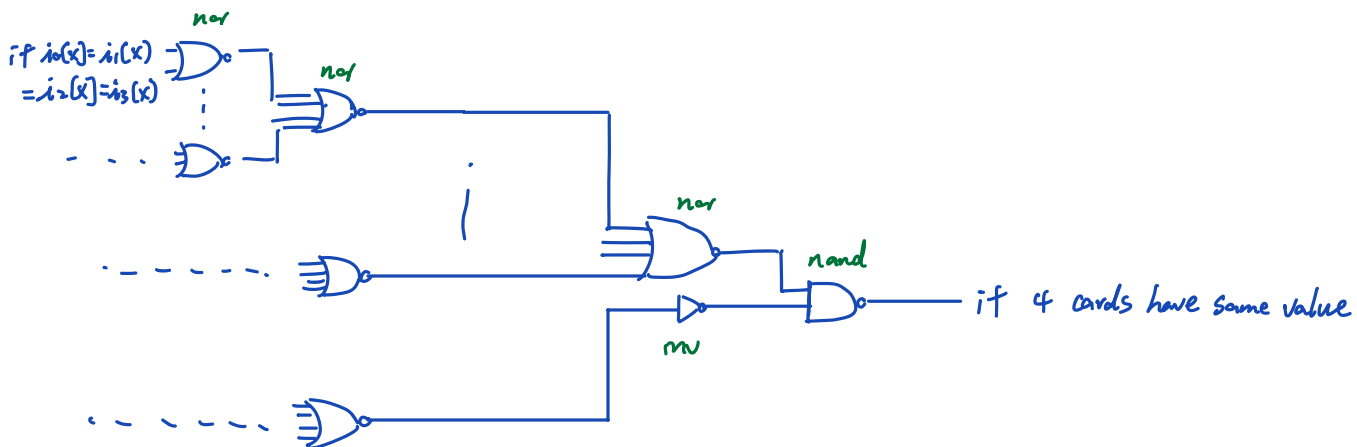
nor

— if two cards have same value
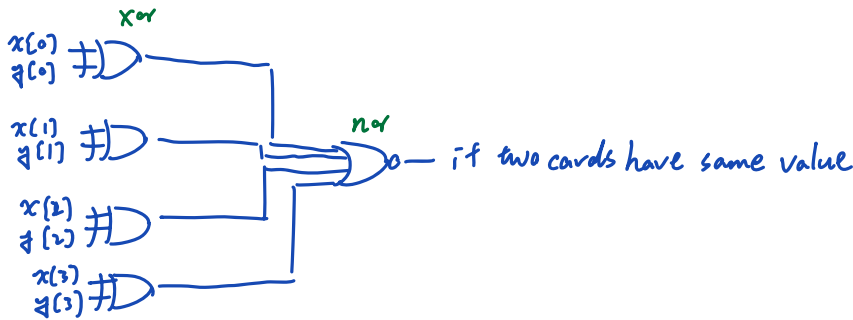
c. identifying if 4 numbers have same value (four_kind_detector)

examine if $i_0 = i_1 = i_2 = i_3$, $i_1 = i_2 = i_3 = i_4$, $i_0 = i_1 = i_2 = i_4$, $i_0 = i_2 = i_3 = i_4$, $i_0 = i_1 = i_3 = i_4$

if $i_0(x) = i_1(x) = i_2(x) = i_3(x)$, then $i_0(x) \cdot i_1(x) \cdot i_2(x) \cdot i_3(x) + \overline{i_0(x) \cdot i_1(x) \cdot i_2(x) \cdot i_3(x)} = 1$

$x = 0, 1, 2, 3$, and we and all the results together


if $i_0(x) = i_1(x)$
$= i_2(x) = i_3(x)$

nor, nor, nor, nand, inv

— if 4 cards have same value

d. identifying if 3 numbers have same value (three_kind_detector)

the circuit is same as four_kind_detector except for the input numbers

e. identifying if there are two pairs in 5 cards

result1 - - -. result2 . . . -

brute force ($i_0 i_1 + i_2 i_3$, $i_0 i_2 + i_1 i_3$, - - --. _) → 15 combinations

using same_value module, and then AND both $i_0 i_1$ and $i_2 i_3$

result1

i

result15

— there are two pairs in 5 cards
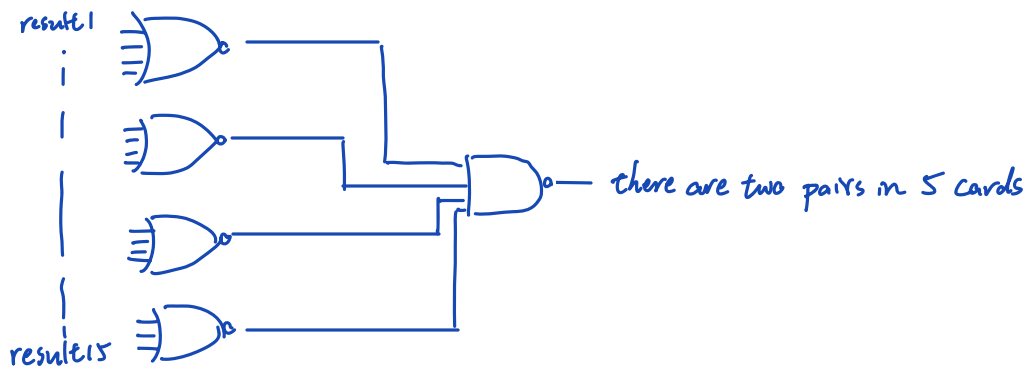
f. identifying straight (straight)

we first transform i_0, i_1, i_2, i_3, i_4 into decimal number (ex. $i_0 = 3$, $i_1 = 4$, $i_2 = 5$, $i_3 = 6$, $i_4 = 7$)

and then use decimal numbers in the chart

	i_0	i_1	i_2	i_3	i_4	$\overline{i_0 \cdot i_1 \cdot i_2 \cdot i_3 \cdot i_4}$	
wire 1	1	1	1	1	1	0	
wire 2	1	1	1	1	1	0	
3	0	1	1	1	1	1	
4	1	0	1	1	1	1	if five 1s are continuous, it means that
5	1	1	0	1	1	1	5 cards are straight
6	1	1	1	0	1	1	
7	1	1	1	1	0	1	(we use brute force to examine it)
8	1	1	1	1	1	0	from A12345 ~ 10JQKA
9	1	1	1	1	1	0	
10	1	1	1	1	1	0	
11	1	1	1	1	1	0	
12	1	1	1	1	1	0	
wire 13	1	1	1	1	1	0	

if $(\text{straight} \cdot \text{samesuit})$, then type = 8

else if (four kind), then type = 7

else if (three same value $\cdot$ two pairs $\cdot \overline{\text{foursamevalue}}$), then typ = 6

else if ($\overline{\text{straight}} \cdot$ samesuit), then type = 5

else if (straight), then type = 4

else if (threesamevalue $\cdot \overline{\text{two pairs}}$), then type = 3

else if ($\overline{\text{threesamevalue}} \cdot$ two pairs $\cdot \overline{\text{four kind}}$), then type = 2

else if ($\overline{\text{threesamevalue}} \cdot \overline{\text{two pairs}} \cdot$ pair), then type = 1

else, then type = 0

all the if-else conditions can be realized by nor. nand and gates.

2. Discussion

To decrease critical path, we use NOR.NAND gates instead of AND, OR gates, due to the fact that AND. OR gates have extra Inverter than NOR. NAND gates. And use parallel gates instead of gates connected in series.

Also, avoid using 2-to-1 MUX while determining the output type

Lastly, avoid using brute force (for example, directly examine if i_0, i_1, i_2, i_3, i_4 is 34567)