3.18 Two-level combinational logic minimization

Simplifying a sum-of-products expression

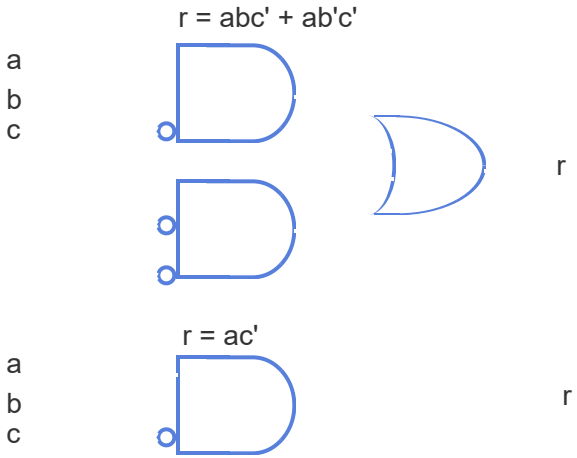
During design, simplifying a sum-of-products expression before converting to a circuit can result in a smaller circuit.

PARTICIPATION ACTIVITY 3.18.1: Simplifying an expression before converting to a circuit.

Start ☐ 2x speed

A store's entry system should activate ringer (output r = 1) if motion is sensed (input a = 1) and daylight is detected (input b = 1) and clerk is not present (input c = 0), OR if motion sensed and no daylight detected and clerk not present.

r = a b c' + a b' c'	
r = a c' (b + b')	Distributive
r = a c' (1)	Complement
r = a c'	Identity



PARTICIPATION ACTIVITY 3.18.2: Simplifying a sum-of-products expression.

Consider the example above.

1) How many literals exist in the original expression?
   - ○ 3
   - ○ 6

2) If each AND or OR gate input requires two transistors, how many transistors does the original expression's circuit require? Ignore NOT gates.
   - ○ 8
   - ○ 16

3) If each AND or OR gate input requires two transistors, how many transistors does the simplified expression's circuit require? Ignore NOT gates.
   - ○ 4
   - ○ 16

Seeking i(j + j') opportunities

Given a sum-of-products expression, knowing what to simplify can be hard. To make simplification opportunities more obv algebraic simplification process is to:

- Convert to sum-of-minterms
- Seek i(j + j') opportunities: ij + ij' = i(j + j') = i

PARTICIPATION ACTIVITY 3.18.3: Seeking i(j + j') opportunities.

Start 2x speed

Original expression: ac + ab'c
ac(1) + ab'c
ac(b + b') + ab'c
abc + ab' c + ab'c
abc + ab' c
ac (b + b')
ac(1)
ac

PARTICIPATION ACTIVITY 3.18.4: Seeking i(j + j') simplification opportunities.

Only type the ? part. Type answers as: ab'

1) y = cd + cd'
y = c(?)

Check Show answer

2) y = c(d + d')
y = c(?)

Check Show answer

3) y = c(1)
y = ?

Check Show answer

4) y = efg + ef'g
y = eg(?)

Check Show answer

5) y = cd' + cd
y = c(?)

Check Show answer

6) y = dc + d'c
y = c(?)

Check Show answer

PARTICIPATION ACTIVITY 3.18.5: First translating to sum-of-minterms, then seeking simplification opportunities.

Simplify. Only type the ? part. Type answers as: ab'

1) y = cd + c
y = cd + c(d + ?)

Check Show answer

2) y = cd + c
y = cd + c(d + d')
y = cd + cd + ?

Check Show answer

3) y = cd + cd + cd'
y = ? + cd'

Check Show answer

4) y = cd + cd'
y = c(?)

Check Show answer

5) y = c(d + d')
y = ?

Check Show answer

Algebraic simplification by hand can be hard

The algebraic simplification process can be hard to do by hand.

PARTICIPATION ACTIVITY 3.18.6: Algebraic simplification can be hard to do by hand.

Start 2x speed

Original expression: ab + a'

ab + a' (b + b')

ab + a'b + a'b'

ab + a'b + a'b + a'b'

(a + a')b + a'(b + b')

(1)b + a'(1)

a' + b

PARTICIPATION ACTIVITY 3.18.7: Simplifying algebraically can be hard.

Consider the example above.

1) What expression came after: ab + a'b + a'b'

- (a + a')b + a'b'
- ab + a'(b + b')
- ab + a'b + a'b + a'b'

2) How many equations were written

during the simplification process?

- 3
- 7
- 21

Provide feedback on this section