Lecture 3

Logic Gates

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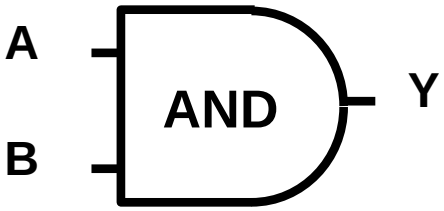
- A logic gate is an electronic circuit used for manipulation of binary data.
  - البوابة المنطقية هي دارة إلكترونية تستخدم لمعالجة البيانات الثنائية.
- There are various logic gates in used in digital computer.
  - هناك العديد من البوابات المنطقية المستخدمة في الكمبيوتر الرقمي.
- Each logic circuit will have a distinct graphical symbol and its operation can be represent as an expression.
  - لكل دائرة منطقية رمز بياني مميز ويمكن أن تمثل عمليتها تعبيرا.
- Each gate will take one or more binary bits as inputs and generates a single binary output that is equal to 1 or 0
  - يكون لكل بوابة مدخل او مدخلان يحملان بيان بالنظام الثنائي وتولد مخرجا ثنائيا واحدا يساوي 1 أو 0

- For each logic gate the operations can be represented as truth table.
- لكل بوابة منطقية يمكن تمثيل عملياتها بجدول الحقيقة.
- Truth table: The input-output relationship of the binary bits in a tabular form is called as a truth table.
- جدول الحقيقة: تمثل علاقة المدخلات والمخرجات من البتات الثنائية على شكل جدول يسمى بجدول الحقيقة.
- The different logic gates available in a digital computer are:
- البوابات المنطقية المختلفة المتاحة في الكمبيوتر الرقمي هي:

AND Function

Text Description ⇒ **Output Y is TRUE if inputs A *AND* B are TRUE, else it is FALSE.**

Logic Symbol ⇒



Truth Table ⇒

INPUTS		OUTPUT
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

AND Gate Truth Table

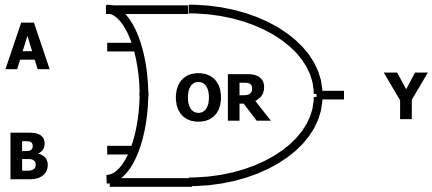
Boolean Expression ⇒ **Y = A x B = A • B = AB**

AND Symbol

OR Function

Text Description ⇒ **Output Y is TRUE if input A OR B is TRUE, else it is FALSE.**

Logic Symbol ⇒



Truth Table ⇒

INPUTS		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

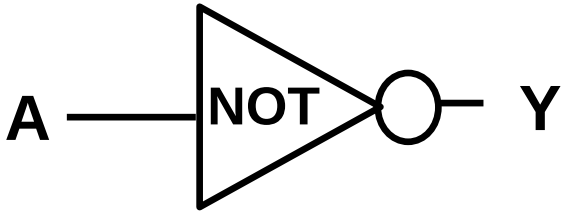
OR Gate Truth Table

Boolean Expression ⇒ **Y = A + B** **OR Symbol**

NOT Function (inverter)

Text Description ⇒ Output Y is TRUE if input A is FALSE, else it is FALSE. Y is the inverse of A.

Logic Symbol ⇒



Truth Table ⇒

INPUT A	OUTPUT Y
0	1
1	0

NOT Gate Truth Table

Boolean Expression ⇒ $Y = \overline{A}$ (NOT Bar)

Alternative Notation

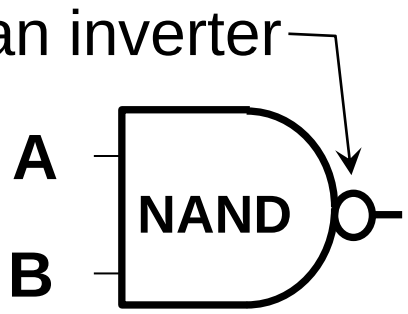
Y = A'

Y = !A

NAND Function

Text Description ⇒ Output Y is FALSE if inputs A *AND* B are TRUE, else it is TRUE.

Logic Symbol ⇒



Truth Table ⇒

INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

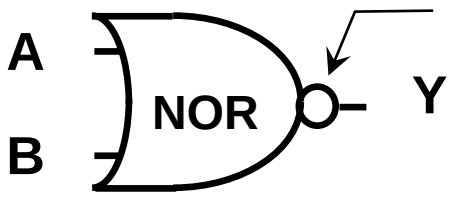
NAND Gate Truth Table

Boolean Expression ⇒ $Y = \overline{A \times B} = \overline{AB}$

NOR Function

Text Description ⇒ Output Y is FALSE if input A *OR* B is TRUE, else it is TRUE.

Logic Symbol ⇒



A bubble is an inverter.

This is an OR Gate with its output inverted.

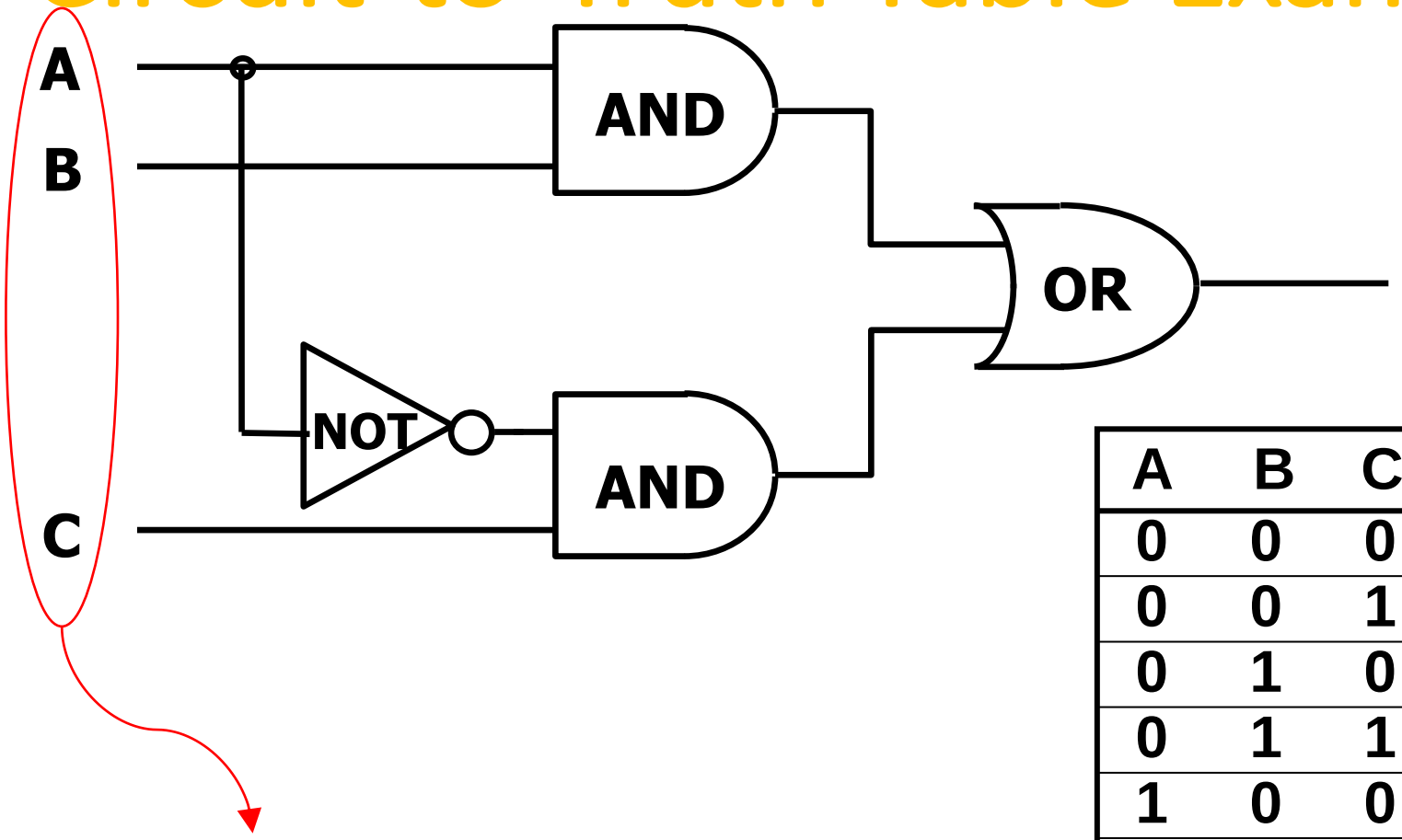
Truth Table ⇒

INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

NOR Gate Truth Table

Boolean Expression ⇒ $\overline{Y = A + B}$

Circuit-to-Truth Table Example

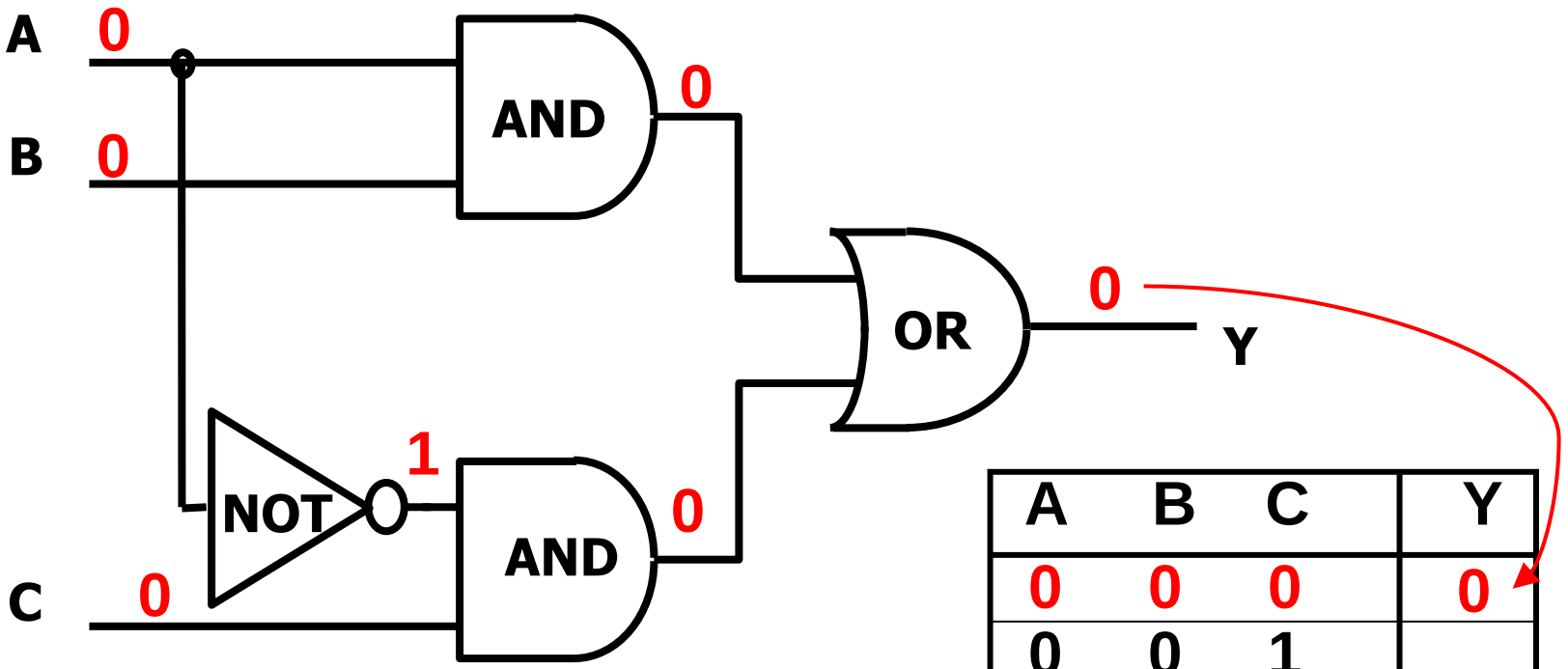


A	B	C	Y
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

$2^{\#\text{ of Inputs}} = \#\text{ of Combinations}$

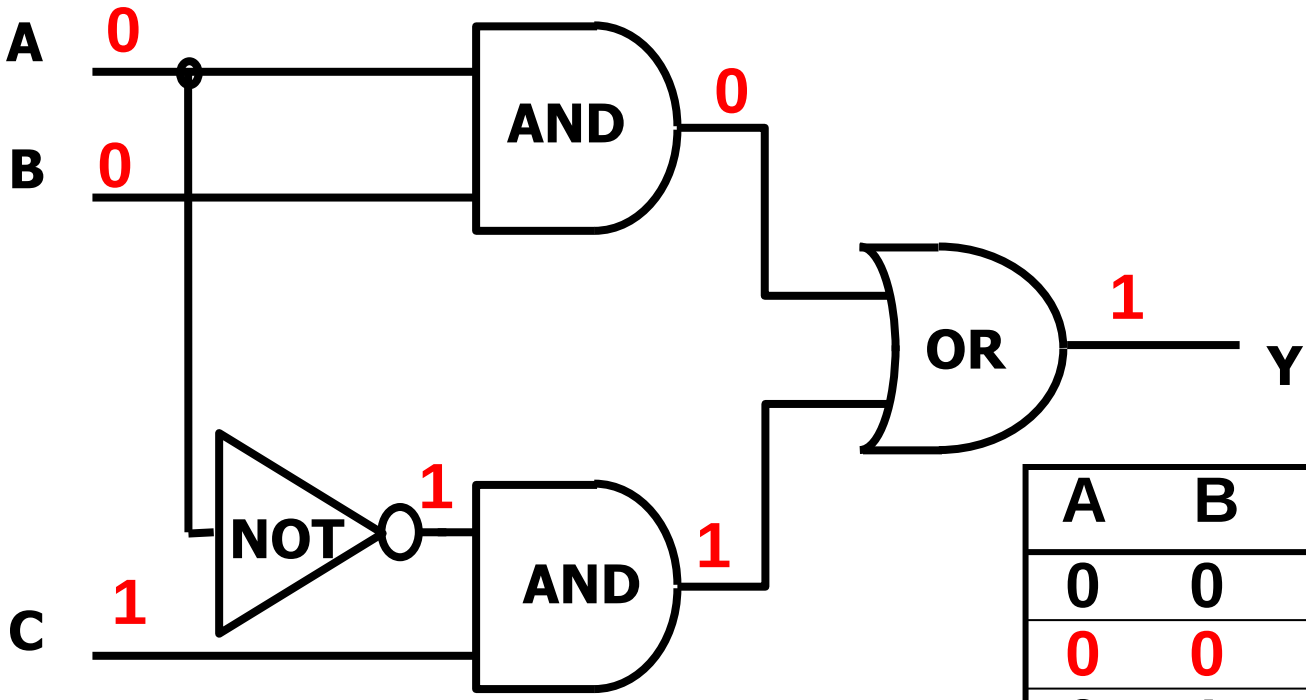
$$2^3 = 8$$

Circuit-to-Truth Table Example



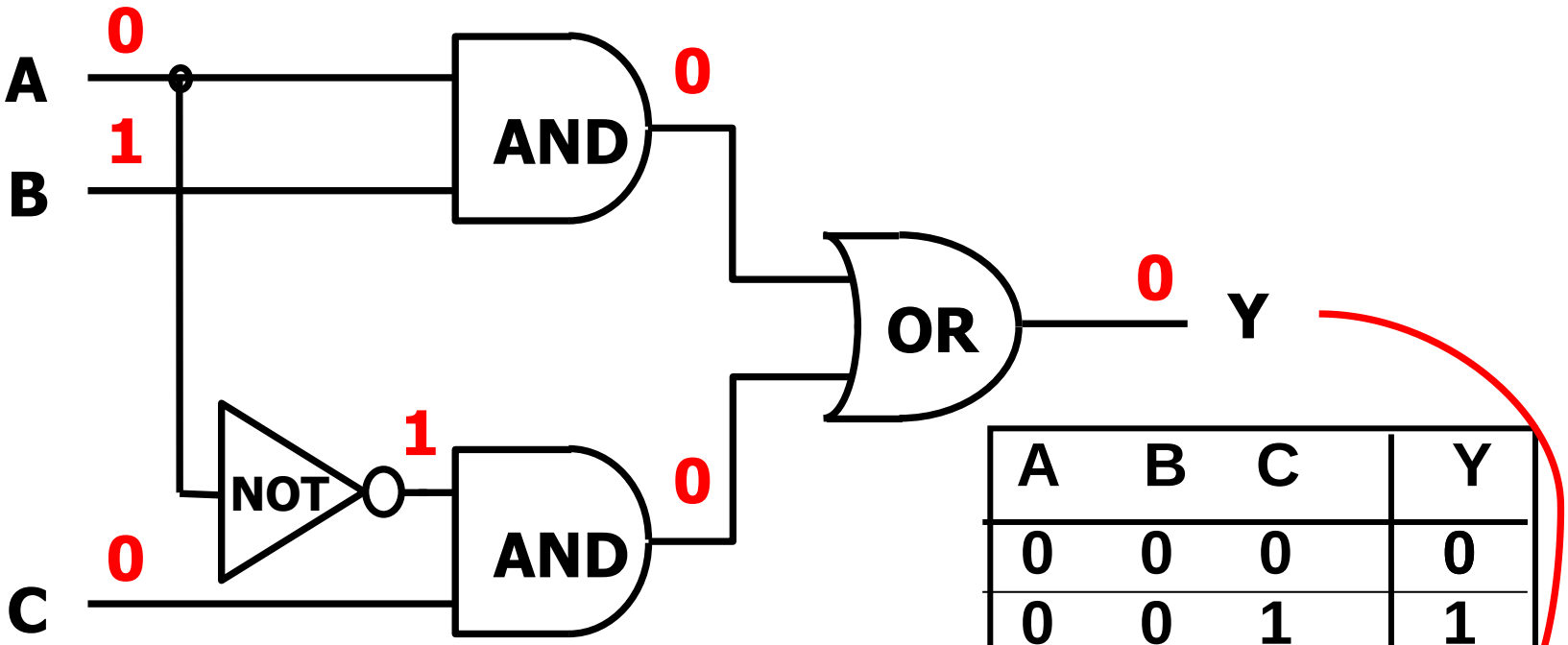
A	B	C	Y
0	0	0	0
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Circuit-to-Truth Table Example



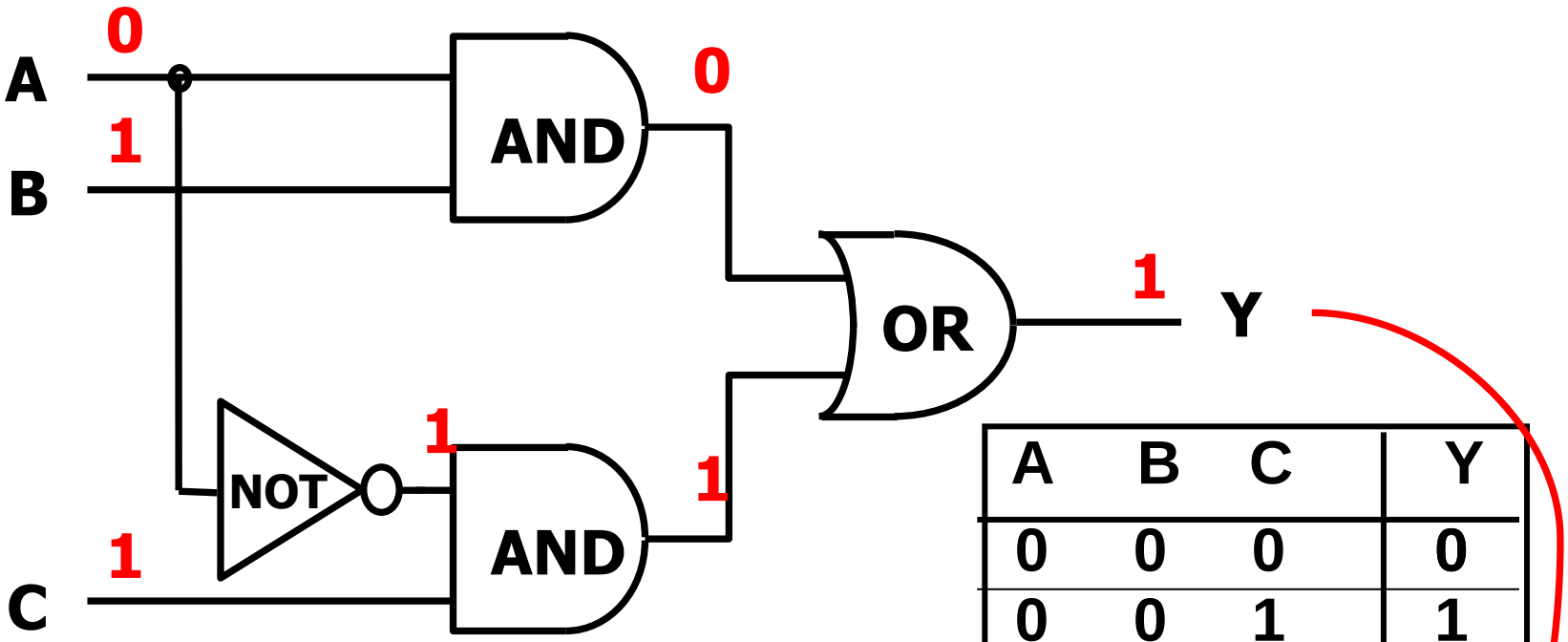
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Circuit-to-Truth Table Example



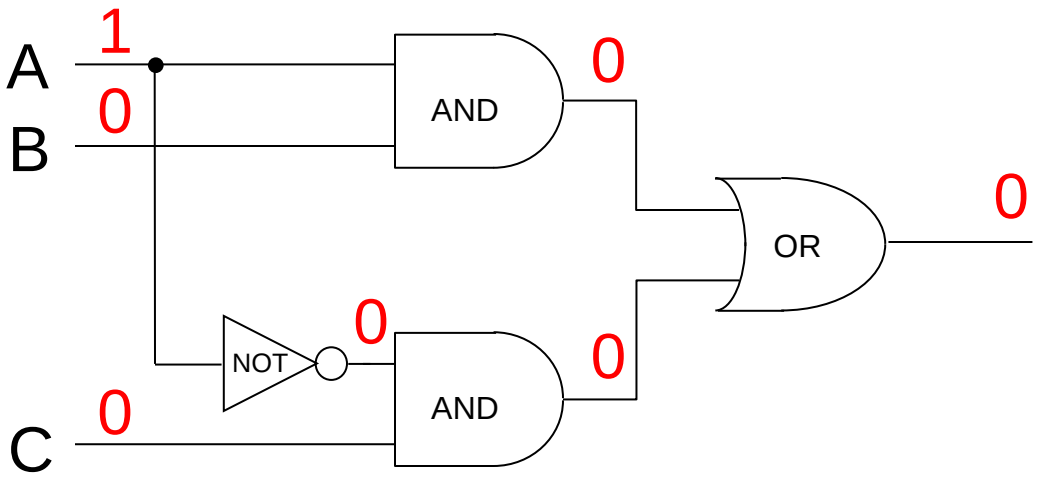
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Circuit-to-Truth Table Example



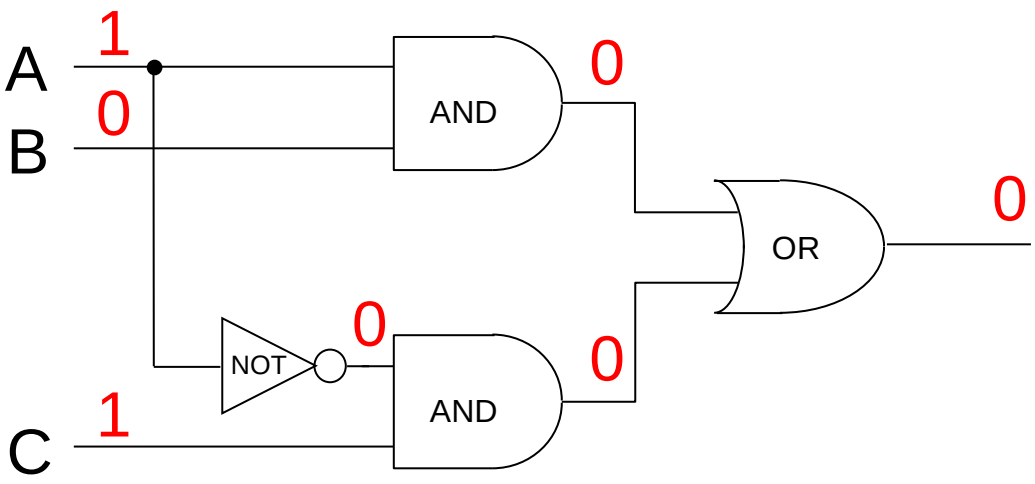
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Circuit-to-Truth Table Example



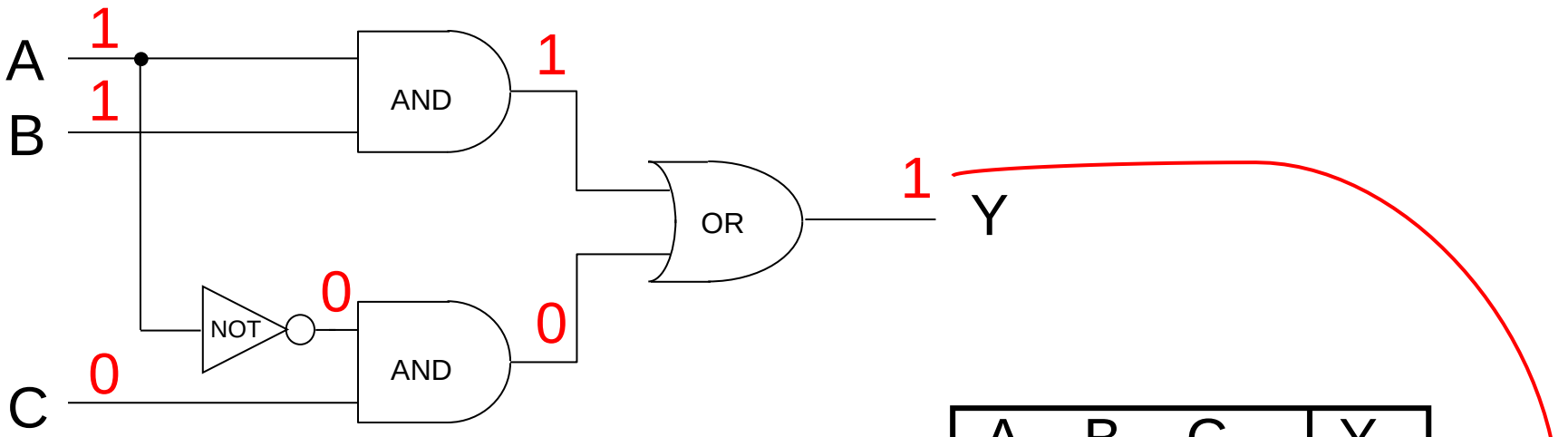
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	
1	1	0	
1	1	1	

Circuit-to-Truth Table Example



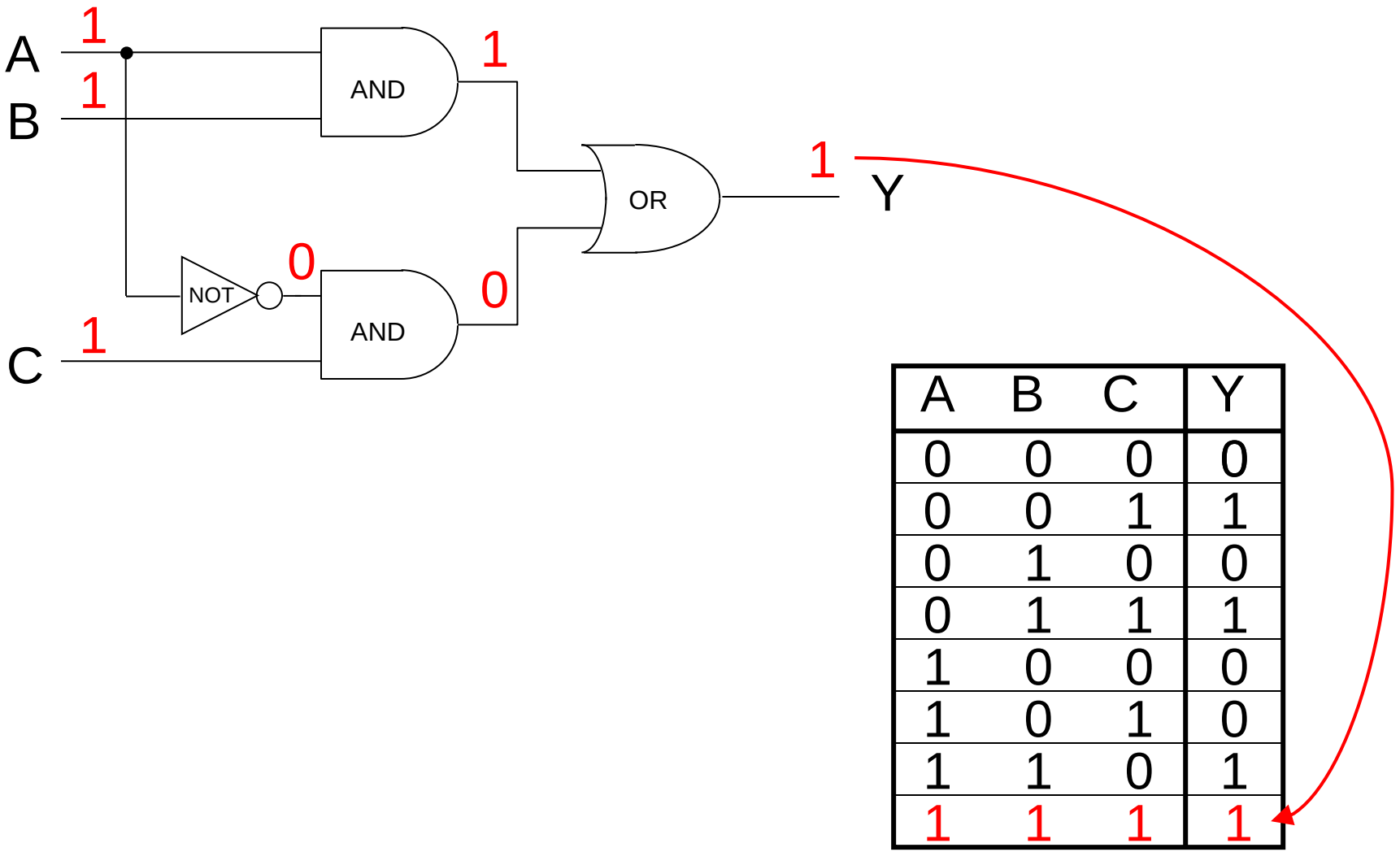
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	
1	1	1	

Circuit-to-Truth Table Example



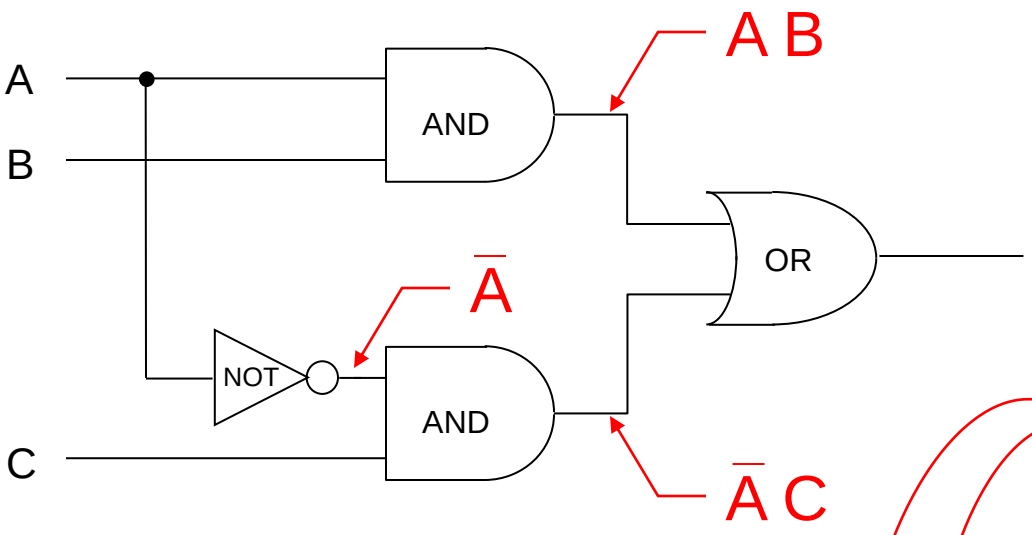
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	

Circuit-to-Truth Table Example



A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

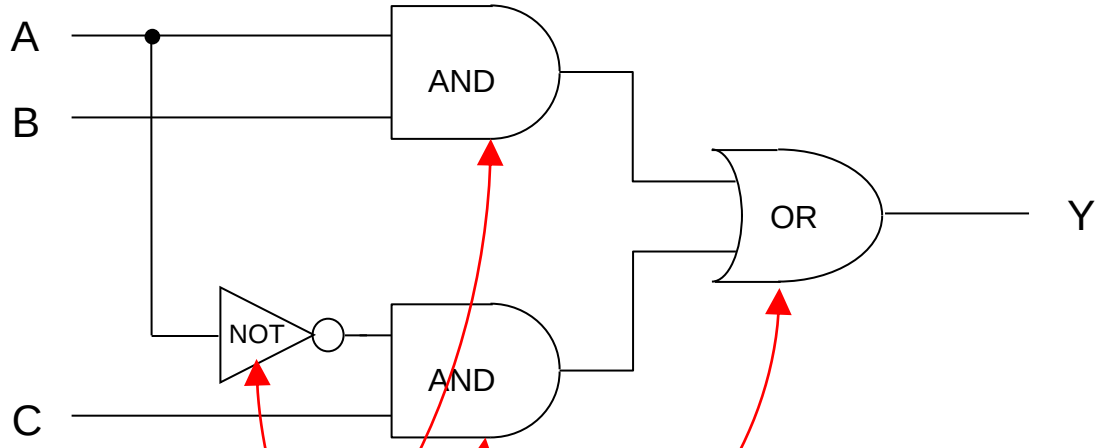
Circuit-to-Boolean Equation



$$Y = \underbrace{A\,B} + \underbrace{\overline{A}\,C}$$

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

A - O - I Logic



AND Gates

OR Gates

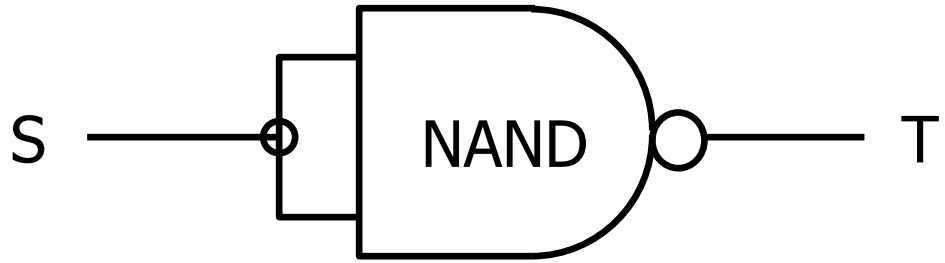
INVERTER Gates

Other Logic Arrangements:

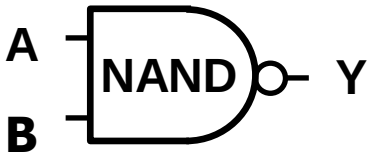
NAND - NAND Logic

NOR - NOR Logic

NAND Gate – Special Application



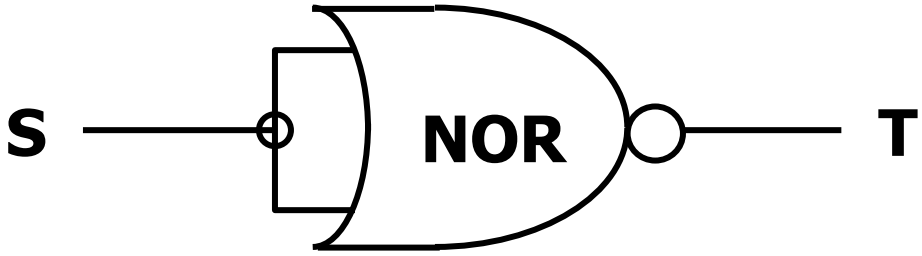
S	T
0	1
1	0



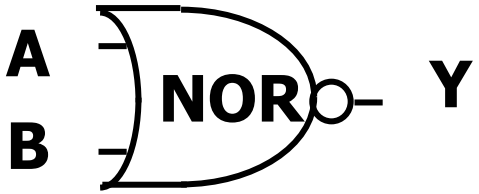
INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Equivalent To An Inverter Gate

NOR Gate - Special Application



S	T
0	1
1	0



INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Equivalent To An Inverter Gate