

## 9.2 Truth Tables

How do the truth values of  $\sim p$ ,  $p \vee q$ ,  $p \wedge q$  depend on the truth values of  $p$  and  $q$ ?

$p$	$\sim p$
T	F
F	T

← (not p)

←  $\sim p$  is true when  $p$  is false

$p$	$q$	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

← (p or q)

}  $p \vee q$  is true when at least one of  $p$  or  $q$  is true

$p$	$q$	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

← (p and q)

←  $p \wedge q$  is true when both  $p$  and  $q$  are true

$p \oplus q$ :  $p$  or  $q$ , but not both

pronounced "p exclusive or q"

"p xor q"

$p$	$q$	$p \oplus q$
T	T	F
T	F	T
F	T	T
F	F	F

$p \oplus q$  is true when exactly one of  $p$  and  $q$  is true

Ex: Build the truth table for  $\sim(p \wedge q)$

$p$	$q$	$p \wedge q$	$\sim(p \wedge q)$
T	T	T	F
T	F	F	T
F	T	F	T
F	F	F	T

Ex: Build the truth table for  
 $(p \oplus q) \vee (p \wedge q)$

$p$	$q$	$p \oplus q$	$p \wedge q$	$(p \oplus q) \vee (p \wedge q)$
T	T	F	T	T
T	F	T	F	T
F	T	T	F	T
F	F	F	F	F

Ex: Build the truth table for  
 $(p \wedge q) \vee r$

→ 3 statements  $p, q, r$

Need  $2 \times 2 \times 2 = 8$  rows

$p$	$q$	$r$	$p \wedge q$	$(p \wedge q) \vee r$
T	T	T	T	T
T	T	F	T	T
T	F	T	F	T
T	F	F	F	F
F	T	T	F	T
F	T	F	F	F
F	F	T	F	T
F	F	F	F	F

Ex: Build the truth table for

$$(p \vee q) \oplus ((p \vee r) \wedge \sim p)$$

→ 3 statements  $p, q, r$   
Need 8 rows

$p$	$q$	$r$	$p \vee q$	$p \vee r$	$\sim p$	$(p \vee r) \wedge \sim p$	
T	T	T	T	T	F	F	T
T	T	F	T	T	F	F	T
T	F	T	T	T	F	F	T
T	F	F	T	T	F	F	T
F	T	T	T	T	T	T	F
F	T	F	T	F	T	F	T
F	F	T	F	T	T	T	T
F	F	F	F	F	T	F	F

$\oplus$