



# INTRODUCTION TO DS

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# WHAT ARE “DISCRETE STRUCTURES” ANYWAY?

- ▶ *Discrete*” –
- ▶ *Structures*”
- ▶ -DISCRETE STRUCTURE
- ▶ DISCRETE OBJECTS

# USES FOR DISCRETE MATH IN COMPUTER SCIENCE

- ▶ Advanced algorithms & data structures
- ▶ Programming language compilers & interpreters
- ▶ Computer networks
- ▶ Operating systems
- ▶ Computer architecture
- ▶ Database management systems
- ▶ Cryptography
- ▶ Error correction codes

# INTRODUCTION

- ▶ LOGIC
- ▶ **PROPOSITIONS**
- ▶ **EXAMPLE 1**

1. Washington, D.C., is the capital of the United States of America.
2. Toronto is the capital of Canada.
3.  $1 + 1 = 2$ .
4.  $2 + 2 = 3$ .

Propositions 1 and 3 are true, whereas 2 and 4 are false.

# PROPOSITIONS EXAMPLES

## ▶ EXAMPLE 2

1. What time is it?

2. Read this carefully.

3.  $x + 1 = 2$ .

4.  $x + y = z$ .

# PROPOSITIONS

- ▶ PROPOSITIONAL CALCULUS OR PROPOSITIONAL LOGIC
- ▶ SOME POPULAR BOOLEAN OPERATORS

<u>Formal Name</u>	<u>Nickname</u>	<u>Arity</u>	<u>Symbol</u>
Negation operator	NOT	Unary	$\neg$
Conjunction operator	AND	Binary	$\wedge$
Disjunction operator	OR	Binary	$\vee$
Exclusive-OR operator	XOR	Binary	$\oplus$
Implication operator	IMPLIES	Binary	$\rightarrow$

# THE NEGATION OPERATOR

▶ Let  $p$  be a proposition. The *negation* of  $p$ , denoted by  $\neg p$

▶ **EXAMPLE 3**

Find the negation of the proposition “Michael’s PC runs Linux” and express this in simple English.

*SOLUTION:* The negation is “It is not the case that Michael’s PC runs Linux.”

▶ The *truth table* for NOT:

$p$	$\neg p$
T	F
F	T

# THE CONJUNCTION OPERATOR

- ▶ **EXAMPLE** If  $p =$  “I will have salad for lunch.” and  $q =$  “I will have steak for dinner.”
- ▶ **CONJUNCTION TRUTH TABLE**

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



# THE DISJUNCTION OPERATOR

- ▶ **EXAMPLE** If  $p =$  “My car has a bad engine.” and  $q =$  “My car has a bad carburetor.”
- ▶ **DISJUNCTION TRUTH TABLE**

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

Note difference from AND

# THE EXCLUSIVE-OR OPERATOR

**EXAMPLE** If  $p$  = “I will earn an A in this course.” and  $q$  = “I will drop this course.”,

► **EXCLUSIVE-OR TRUTH TABLE**

$p$	$q$	$p \oplus q$
T	T	<b>F</b>
T	F	T
F	T	T
F	F	F

Note difference from OR.

# THE IMPLICATION OPERATOR

- ▶ The conditional statement (aka *implication*)  $p \rightarrow q$  states that  $p$  implies  $q$ .
- ▶ **EXAMPLE** If  $p$  is true, then  $q$  is true; but if  $p$  is not true, then  $q$  could be either true or false.

let  $p$  = "You study hard."  $q$  = "You will get a good grade."

- ▶ **IMPLICATION TRUTH TABLE**

$p$	$q$	$p \rightarrow q$
T	T	T
T	F	<b>F</b>
F	T	T
F	F	T

} The only False case!