Propositional logic lecture 2

DR. Herlina Jayadianti., S.T.,M.T

Agents that reason logically

- A *logic* is a:
  - Formal language in which knowledge can be expressed
  - A means of carrying out reasoning in the language

- A Knowledge base agent

Language Examples

- Programming languages
  - Formal, not ambiguous
  - Lacks expressivity (e.g., partial information)
- Natural Language
  - Very expressive, but ambiguous:
    - *Flying planes can be dangerous.*
    - *The teacher gave the boys an apple.*
  - Inference possible, but hard to automate
- Good representation language
  - Both formal and can express partial information
  - Can accommodate inference

Components of a Formal Logic

- Syntax: symbols and rules for combining them

  What you can say

- Semantics: Specification of the way symbols (and sentences) relate to the world

  What it means

- Inference Procedures: Rules for deriving new sentences (and therefore, new semantics) from existing sentences

  Reasoning

Propositional Logic

What is a Proposition?

- Propositions are the *meanings* of statements.
  - I have no money

- Meanings are the thoughts, concepts, ideas we are trying to convey through speech and writing.

Simple Propositions

- This box contains of chili
- Bangkok is the capital of Vietnam
- Ir.Sukarno is the first president of Indonesia
- "Kotagede" has 9 letters.
- I am hungry
- This thing is solid
- India is a country
- 1 + 101 = 110

Simple Propositions

- Fast foods tend to be unhealthy.
- Parakeets are colorful birds.

- *Simple propositions are grammatically independent expressions of information.*

Compound Propositions – operator or functor

If fast foods tend to be unhealthy,

then you shouldn't eat it.

Parakeets are colorful birds,

and colorful birds are good to have at home.

People are free, if and only if they can choose their actions and there are no forces compelling those actions.

The Focus of Propositional Logic

- Propositional *truth* is determined by consulting typical sources of information.
- Propositional *logic* is determined by examining how various propositions are related.

Exercise

Exercise$_1$

Elephant is bigger than mouse

Is this a statement? **Y**

Is this preposition? **Y**

What is the value of truth? **T**

Exercise$_2$

"600 < 123"

Is this a statement? **Y**

Is this preposition? **Y**

What is the value of truth of this preposition? **F**

Exercise$_3$

"y>5"

Is this a statement? **Y**
Is this preposition? **N**
What is the value of truth?
Deppend on value y, but y is not specified). We call it propositional function or open sentence

Exercise$_4$

“Today is Feb.16 and 99<5”

Is this a statement? **Y**

Is this preposition? **Y**

What is the value of truth? **F**

Exercise$_5$

“Please don’t sleep”

Is this a statement? **N**

This is a request

Is this preposition? **N**

Only statement can be a preposition

Exercise6

“x<y if and only if y>x”

Is this a statement? **Y**

Is this a preposition ? **Y**

… because the truth value <u>not</u> depend on the value assigned to x and y

What is the value of truth of this preposition? **T**

Not Preposition

1) Close the door
2) No Smoking
3) Number X is between 1 and 0

Reason :

- *(1) and (2) can not be true or false*
- *(3) included in predicate logic because there is a variable x whose value has not been determined.*

Referensi : Rinaldi Munir 09/04/2017

Basics of Propositional Logic

- All arguments are reducible to symbols, which represent *either* elements of an argument *or* ways these elements are put together.
- All arguments contain statements, by definition. Each statement is represented by a "**propositional variable**" – p, q, r, s
- All arguments also contain connections, or ways in which individual propositions are related. Each of these connections are represented by one of five "**operators**":

Putting propositional variables together with operators creates a "statement form," or a symbolic blueprint identifying typical structures of English expressions.

Propositional Operators

~ ("tilde," negation)

Not, it is false that, conjunctions like "don't"

$\wedge$ or • ("dot," conjunction)

And, also, but, in addition, moreover

v ("wedge," either-or)

Or, unless

> or $\rightarrow$ ("implication" or "conditional," if,then).

Is a sufficient (or necessary) condition of, if-then, implies, given that, only if

Ξ or $\leftrightarrow$ ("biconditional," if and only if)

If and only if, is equivalent to, is a sufficient and necessary condition of

$\oplus$: "xor", atau "exclusive or"

Tips for Translation

- Use "**clue words**":
  - "If, then"; "on the condition that": **>**
  - Both; and; also; etc: ●
  - Either, or; or maybe both: **v**
  - If one, then the other; if and only if; always occur together:
  - Negation; it is not true that, not: ~

Note on the "Tilde"

1. All operators *except* the tilde must relate at least two propositions.

2. The tilde negates either a proposition directly, or an operator relating to propositions (by standing directly before a parentheses/bracket/etc.) .

Examples of "Tilde" Functions

~ p = not p; p is not true, etc

~ p ● ~ q = p is false and q is false; p and q are both false

~ (p ● q) = not *both* p and q (maybe one is true and one false)

Simbolic Notation

- The letters A, B, C, D or P, Q, R, S (p, q, r, s) can be used as a **variable Proposition**
- The letters **T** and **F** are used to constant Proposition is **True** and **False**

Negation (not)

If **A** is any proposition then the statement "not A" or **"negation A"** will be worth False if value "A" is True (vice versa) and written by

$$\neg \mathbf{A}$$

("¬" unary) and the **Truth table is**

A	¬A
T	F
F	T

Conjunction (and)

Conjunction is a binary operator or dyadic (dyadic).
If A and B is a proposition, statement of A and B will be worth **True** if and only if both A and B have a truth value T, and written by $\mathbf{A \wedge B}$

Truth table

A	B	$A \wedge B$
T	T	T
T	F	F
F	T	F
F	F	F

Disjunction (or)

Disjunction (alternative corresponding) to the form "**One of the** ... **or** ..." (Either .. Or ..).

The statement **"A or B"** is worth **T** *if and only if* either A or B (or both) worth T, and is written:

$A \vee B$

A	**B**	**$A \vee B$**
T	T	T
T	F	T
F	T	T
F	F	F

Exclusive or

Exclusive disjunction or **exclusive or** is a logical operation that outputs true only when inputs differ (one is true, the other is false)

A	B	A ⊕ B
T	T	F
T	F	T
F	T	T
F	F	F

Implication $A \rightarrow B$

"If Herlina go abroad then she has a passport"

The explanation is as follows:

If Herlina go abroad (T) and she has a passport (T), then it is legal (T)

If Herlina go abroad (T) and she didn't have a passport (F), then it is illegal (F)

If Herlina not go abroad (F) and she had a passport (T), then it is legal (T)

If Herlina not go abroad (F) and he didn't have a passport (F), then it is legal (T)

Implication

A	B	$A \to B$
T	T	T
T	F	F
F	T	T
F	F	T

1). "*If A then B*"
2). "*A implies B*"

3). "*B if A*"
4). "*A if only B*"

5). "B *is a necessary condition for A*"
6). "*A is a necessary condition for B*"

Equivalency

Statement “ A equivalent with B” is T
If only IF A and B has the same truth

$$\mathbf{A} \leftrightarrow \mathbf{B}$$

in table truth use this symbol $\Leftrightarrow$

Equivalency

A	B	$A \leftrightarrow B$
T	T	T
T	F	F
F	T	F
F	F	T

Sifat :

1) Commutative ($A \leftrightarrow B = B \leftrightarrow A$)
2) Associative ($(A \leftrightarrow B) \leftrightarrow r = A \leftrightarrow (B \leftrightarrow r)$)
3) Statement $\neg(A \leftrightarrow B)$ have the same table truth $A \vee B$ (show it)

Equivalency

- Note: "A if and only if B"
- Statement A $\leftrightarrow$ B is also called *biconditional* of A and B, because it always has a trurth table =

$$A \leftrightarrow B \;=_T\; (A \rightarrow B) \wedge (B \rightarrow A) \quad or \quad (A \rightarrow B) \wedge (A \leftarrow B)$$

- Written $A \leftrightarrow B =_T (A \rightarrow B) \wedge (B \rightarrow A)$

Resume

A	B	$\neg$A	A $\wedge$ B	A $\vee$ B	A $\oplus$ B	A $\rightarrow$ B	A $\leftrightarrow$ B
T	T	F	T	T	F	T	T
T	F	F	F	T	T	F	F
F	T	T	F	T	T	T	F
F	F	T	F	F	F	T	T

Ref

Exercise

Where that proposition?

- *Ngawi is the capital of East Java.*
- *No smoking*
- *119 is an integer*
- *open the door*
- *Logic informatics is easy*
- *Yogyakarta is a student city*
- *Eat a lot*
- *Make a list of statements by 50*

Exercise 2

Let A, B, and C are propositional variables
A = You got the flu
B = You study hard
C = you take the exam
D = you pass the exam

Change the following expression becomes a statement in Indonesian

1. $A \rightarrow \neg C$
2. $(B \land C) \rightarrow D$
3. $\neg A \land \neg B \land C \rightarrow \neg D$

Exercise 3

Determine the value of the truth of the statements below:

- If Jakarta is not the capital of Indonesia, then 9 is not a prime number
- 2 + 2 = 2x2 only when 2 = 0
- Necessary and sufficient conditions that 7 is a prime number is located in East Java Kebumen.
- If 12 is divisible by 4 is equivalent to 12 numbers, the even number (a + b) ^ 2 = a ^ 2 + 2ab + b ^ 2

Exercise 4

Write the truth table

1. $\neg(\neg A \wedge \neg B)$
2. $A \wedge (A \vee B)$
3. $((\neg A \wedge (\neg B \wedge C)) \vee (B \wedge C)) \vee (A \wedge C)$
4. $(A \wedge B) \vee (((\neg A \wedge B) \rightarrow A) \wedge \neg B)$

JAWABAN **¬(¬ A ∧ ¬ B)**

A	B	¬ A	¬ B	¬ A ∧ ¬ B	¬(¬ A ∧ ¬ B)
T	T	F	F	F	T
T	F	F	T	F	T
F	T	T	F	F	T
F	F	T	T	T	F

Thank you
See you next week