

CSE215

Foundations of Computer Science

Instructor: Zhoulai Fu

State University of New York, Korea

Our TA



Email: cheayoung.park@stonybrook.edu

Office Hour:

Monday ~ Thursday : 6:00 pm - 8:00 pm

Education

The State University of New York- SUNY, Korea (SUNY Korea), 2021 Fall~
Applied Mathematics and Statistics Major
Computer Science Minor

Korea International School Jeju, ~2021

Experience

Student Research with Professor Suil O, 2022
Survey of 4 Color Theorem by Robin Thomas, Treewidth, Spectral Graph Theory.

Research Assistant with Professor Ky Tran, 2022-2023

Mulligan Golf Club Member, 2022

Campus Police, 2022

Links

- Course website: https://github.com/zhoulaifu/23_cse215_spring/
- SBU course website: <https://www3.cs.stonybrook.edu/~pramod.ganapathi/CSE215.html>
- Online Ocaml: <https://www.jdoodle.com/compile-ocaml-online/>
- Online Java: <https://www.jdoodle.com/online-java-compiler/>
- Online Python: <https://www.jdoodle.com/python3-programming-online/>
- ChatGPT: <https://chat.openai.com/chat>

Learn to use ChatGPT for your learning

ZE

Show me an example of functional programming in Java.



Certainly! Here's an example of functional programming in Java using lambda expressions:

typescript

Copy code

```
import java.util.Arrays;
import java.util.List;

public class FunctionalProgrammingExample {
    public static void main(String[] args) {
        List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5);

        // Using lambda expression to square each number in the list
        numbers.stream().map((number) -> number * number).forEach(System.out::println);

        // Using method reference to print each number in the list
        numbers.forEach(System.out::println);
    }
}
```

In this example, we use a lambda expression to square each number in the `numbers` list using the `map` method, and then we use the `forEach` method to print the resulting list. This is an example of functional programming because we are using a functional-style approach to processing the data in the list. We're not modifying the original list, but instead creating a new one using a function that maps each element to a new value.

Knowing that sometimes ChatGPT can be entirely wrong

ZE

Is there an US consulate in Incheon, South Korea?



Yes, there is a U.S. Consulate General in Incheon, South Korea. The Consulate General is located at 10 Namchon-ro 141beon-gil, Songdo-dong, Yeonsu-gu, Incheon, South Korea. It provides consular services for U.S. citizens, including passport services, notarial services, and emergency assistance, as well as visa services for South Korean citizens who wish to travel to the United States.

Today's objectives

To understand

- What is propositional logic and scope of our study
- Truth table
- Logical Equivalence

Proposition

Definition

- A **statement** or **proposition** is a sentence for which a truth value (either true or false) can be assigned

True or False?

- The atomic number of Oxygen is 8
- $1 + 1 = 3$
- (Judge asking Witness) The man chased the thief until he fell.
- My mom never made cakes, which we hate.
- There exists life in other planets.
- If earth is round, I can return to where I am by traveling toward a certain direction.
- If Luna drops to 0 won, I will go bankrupt.
- $a \wedge b \rightarrow a$
- $(a \wedge \sim a)$

Scope of our study

- Mathematical logic, not ambiguous English
- Compound statements, not unit statements
- So, we will check if a proposition like $(p \rightarrow q) \rightarrow (q \rightarrow p)$ is true or false

Why logic?

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Artificial Intelligence 47 (1991) 31–56
Elsevier

Logic and artificial intelligence

Nils J. Nilsson

Computer Science Department, Stanford University, Stanford, CA 94305, USA

Received February 1989

Abstract

Nilsson, N.J., Logic and artificial intelligence, Artificial Intelligence 47 (1990) 31–56.

The theoretical foundations of the logical approach to artificial intelligence are presented.

- Quote: “Logic provides the vocabulary and many of the techniques needed both for analyzing the processes of representation and reasoning and for synthesizing machines that represent and reason.”

Example: Software Intelligence used at Facebook, Microsoft, and Google

```
5     int x = 0;
6 -    while (x < 10){
7         x = x + 1;
8 }
```

<http://th.cpp.sh/5p7zo>

Without executing the code, what will the value of x become after the loop ends?

- Answer: x must equals to 10. Following three facts
 - $x \geq 10$ after the loop,
 - $x < 11$ within the loop
 - x is an integer

How to check truthfulness of propositions?

Compound statements

Definition

- A **compound statement** is a complex sentence that is obtained by joining **propositional variables** using **logical connectives**

Logical operator	Notation	Read as
Negation	$\sim p$	not p
Conjunction	$p \wedge q$	p and q
Disjunction	$p \vee q$	p or q
Conditional	$p \rightarrow q$	p implies q if p , then q p only if q q if p q , provided that p
Biconditional	$p \leftrightarrow q$	p if and only if q
Logical equivalence	$p \equiv q$	p logically equivalent to q

Examples

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

Truthfulness of compound statements

Negation ($\sim p$)

Definition

- **Negation** of a statement p , denoted by $\sim p$, is a statement obtained by changing the truth value of p .

p	$\sim p$
T	F
F	T

Truthfulness of compound statements

Conjunction ($p \wedge q$)

Definition

- **Conjunction** of statements p and q , denoted by $p \wedge q$, is a statement such that it is true if both p and q are true and it is false, otherwise.

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

Truthfulness of compound statements

Disjunction ($p \vee q$)

Definition

- **Disjunction** of statements p and q , denoted by $p \vee q$, is a statement such that it is false if both p and q are false and it is true, otherwise.

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

Truthfulness of compound statements

Exclusive or ($p \oplus q$)

Definition

- **Exclusive or** of statements p and q , denoted by $p \oplus q$, is defined as p or q but not both. It is computed as $(p \vee q) \wedge \sim(p \wedge q)$

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

Example: Do you want Kimchi, or do you want Gimbap?

Truthfulness of compound statements

Definition

- **Conditional or implication** is a compound statement of the form “if p , then q ”. It is denoted by $p \rightarrow q$ and read as “ p implies q ”. It is false when p is true and q is false, and it is true, otherwise.

$p \rightarrow q$ seen as
 $\sim p \vee q$

p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

Examples: False \rightarrow Anything is true!

- If $1+1 = 3$, then $1 = 0$
- If the earth is plat, I am walking on the moon

Truthfulness of compound statements

Biconditional statement ($p \leftrightarrow q$)

Definitions

- The **biconditional** of p and q is of the form “ p if and only if q ” and is denoted by $p \leftrightarrow q$. It is true when p and q have the same truth value, and it is false, otherwise.
- $p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$

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

Examples

- Assume x and y are real numbers.
“ $x^2 + y^2 = 0$ if and only if $x = 0$ and $y = 0$.”

Precedence of Logical Operators

Priority	Operator	Comments
1	\sim	Evaluate \sim first
2	\wedge	Evaluate \wedge and \vee next; Use parenthesis to avoid ambiguity
	\vee	
3	\rightarrow	Evaluate \rightarrow and \leftrightarrow next; Use parenthesis to avoid ambiguity
	\leftrightarrow	
4	\equiv	Evaluate \equiv last

- $p \vee q \wedge r$ reads as ...
- $\sim p \rightarrow q$ reads as ...
- $p \rightarrow q \wedge q \rightarrow p$ reads as ...

**Exercise 1: check truthfulness of
 $(p \rightarrow q) \rightarrow (q \rightarrow p)$ with a truth table**

Break;

Logical Equivalence

To finish by 1h50pm

Logic equivalence

Definition

- Two statement forms p and q are **logically equivalent**, denoted by $p \equiv q$, if and only if they have the same truth values for all possible combination of truth values for the propositional variables

Checking logical equivalence

1. **Construct and compare truth tables** (most powerful)
2. Use logical equivalence laws

Logical equivalence: Example

Problem

- Show that $p \wedge (q \vee r) \not\equiv (p \wedge q) \vee r$

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

**Exercise 2: check the logical equivalence
between $(p \rightarrow q)$ and $(\neg q \rightarrow \neg p)$**

Two special logical equivalence: Tautology and contradiction

Definitions

- A **tautology** is a statement form that is always true regardless of the truth values of the individual statements substituted for its statement variables.
- A **contradiction** is a statement form that is always false regardless of the truth values of the individual statements substituted for its statement variables.

Examples

- $p \vee \sim p$ ▷ Tautology
- $p \wedge \sim p$ ▷ Contradiction

The secret of a fortune teller

- Three students ask a fortune teller if they got an “A” in the exam
- The fortune teller says nothing but shows 1 finger
- If they all got A → 1 is right
- If they all failed to get A → 1 is right
- If one students get A → 1 is right
- If two students get A (meaning one does not) → 1 is right
- **The fortune teller will always be right, since he said a tautology.**



See how logic saved Chris Gardner



<https://www.youtube.com/watch?v=W2r4BUB-Rsc>

- Interviewer (giving a proposition): What would you say, if a guy walked in for an interview with such a bad T-shirt, and I hired him?
- Chris Gardner (thinking about logic): He must have really nice pants.

What would you say if a person with such a T-shirt walking into the interview, and I hired him

- Interviewer's proposition: Bad-T-shirt \wedge Get-hired
- Common-sense: Bad-T-shirt $\rightarrow \sim$ Get-hired
- If Chris follows common-sense and interview's proposition, he will obtain \sim Get-hired \wedge Get-hired. That means **contradiction**.
- Never tell interviewers that they say a contradiction.
- So, Chris has to challenge the common-sense, to argue Bad-T-shirt $\rightarrow \sim$ Get-hired is **false**.
- Chris knows that “Bad-T-shirt $\rightarrow \sim$ Get-hired” and “Get-hired $\rightarrow \sim$ Bad-T-shirt” are **equivalent**
- So, Chris is now thinking what to imply from Get-hired?
- Since Get-hired means there must be some extraordinary quality. Chris thinks of two things:
Get-hired \rightarrow Nice-T-shirt \vee Nice-Pants
- But Nice-T-shirt contradicts with Interviewer's proposition, so Christ concludes “Nice-Pants”



\rightarrow Get Hired

Let's call it a day!

- Propositional logic.
- Truth Table.
- Logical Equivalence.
- Tautology and Contradiction.

Thank you for your attention!