



The Introduction To Artificial Intelligence

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The Introduction to Artificial Intelligence

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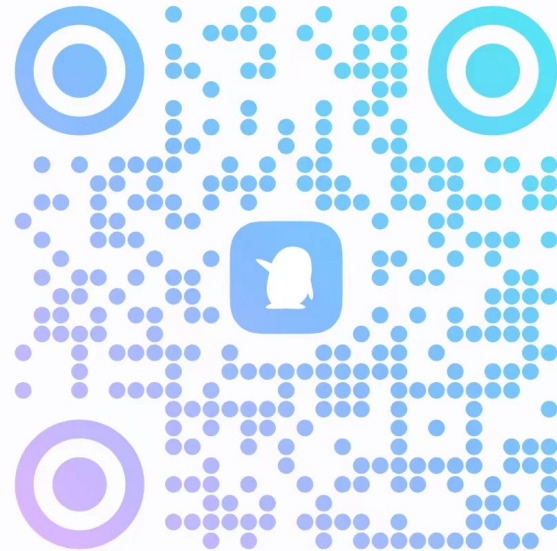
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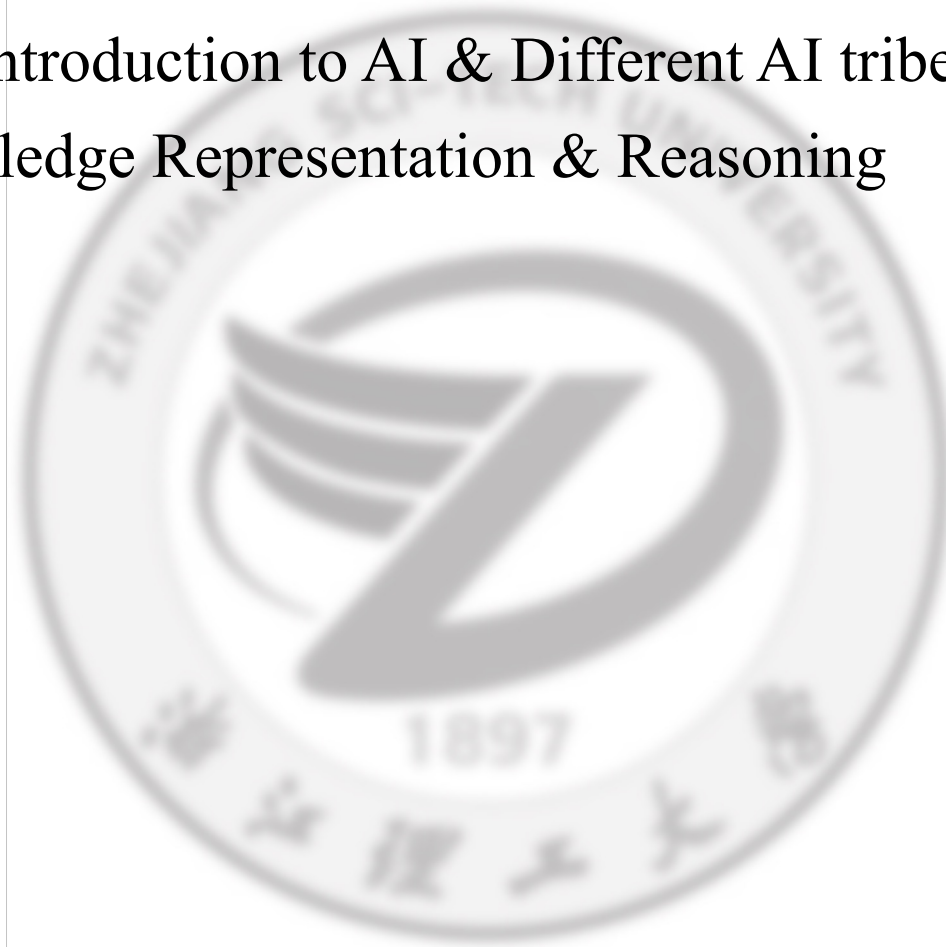
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回答: 曾煜妮

The Introduction to Artificial Intelligence

- Part I Brief Introduction to AI & Different AI tribes
- ✚ • Part II Knowledge Representation & Reasoning



OUTLINE

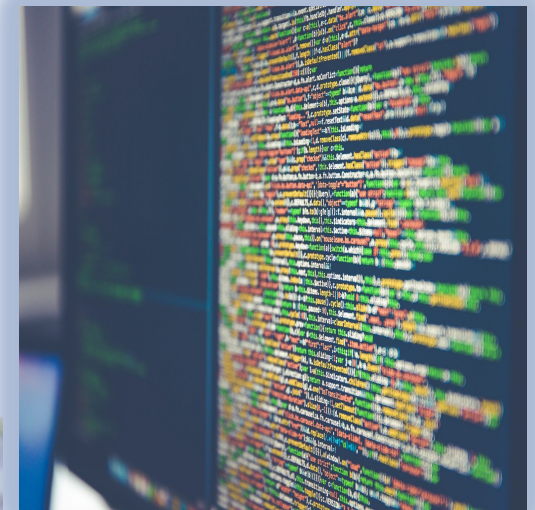
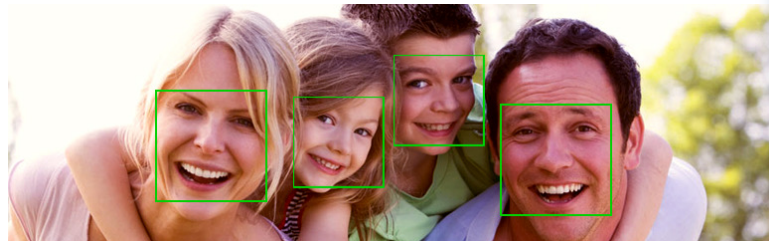
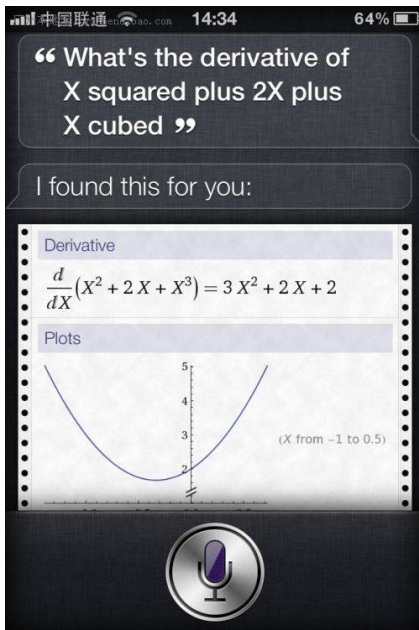
- *1.1 Brief Review*
- 1.2 Knowledge Representation & Reasoning



1.1 Brief Review

□ What Is Artificial Intelligence?

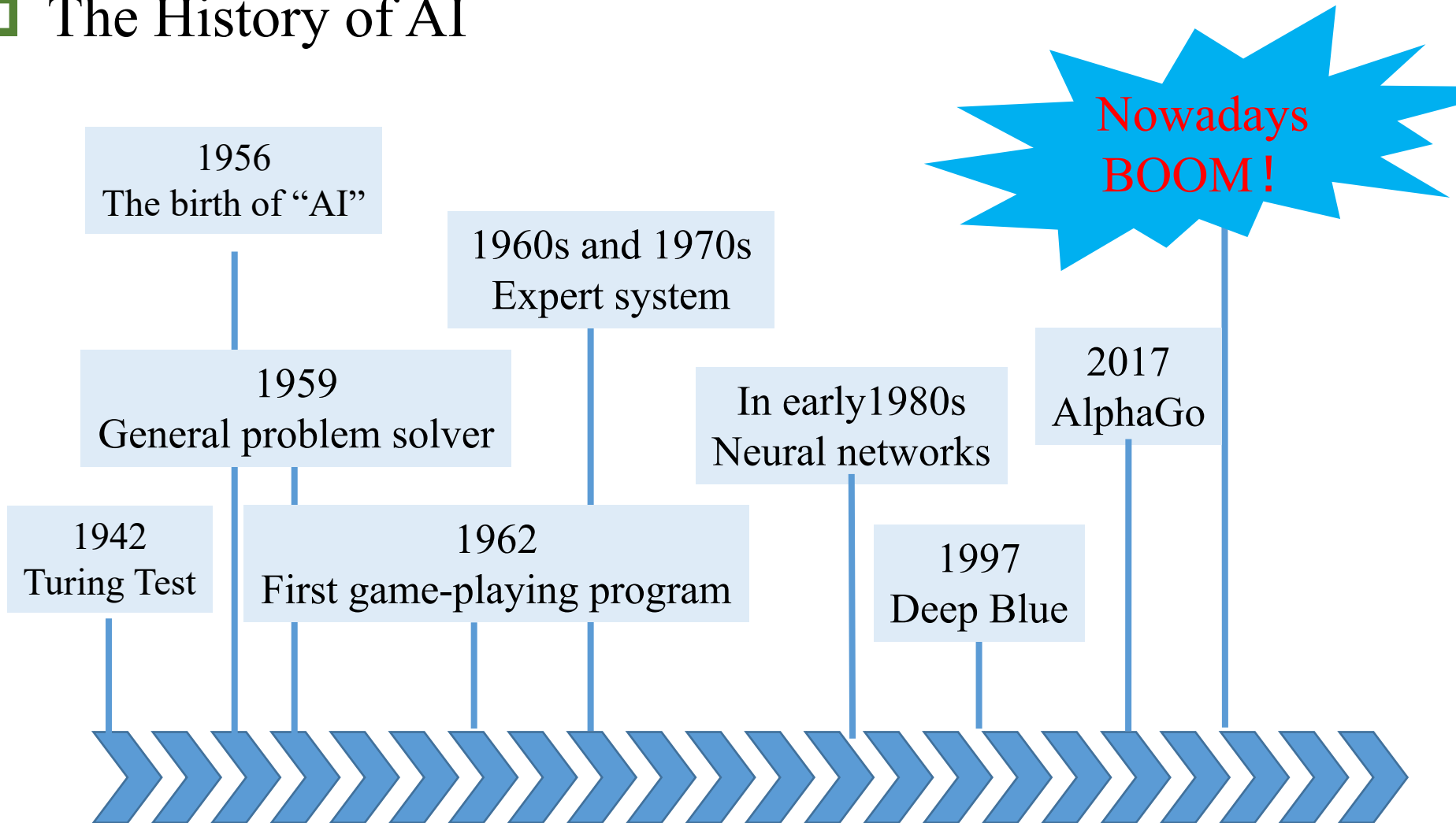
Actually,
artificial intelligence is **intelligence** exhibited by machines.



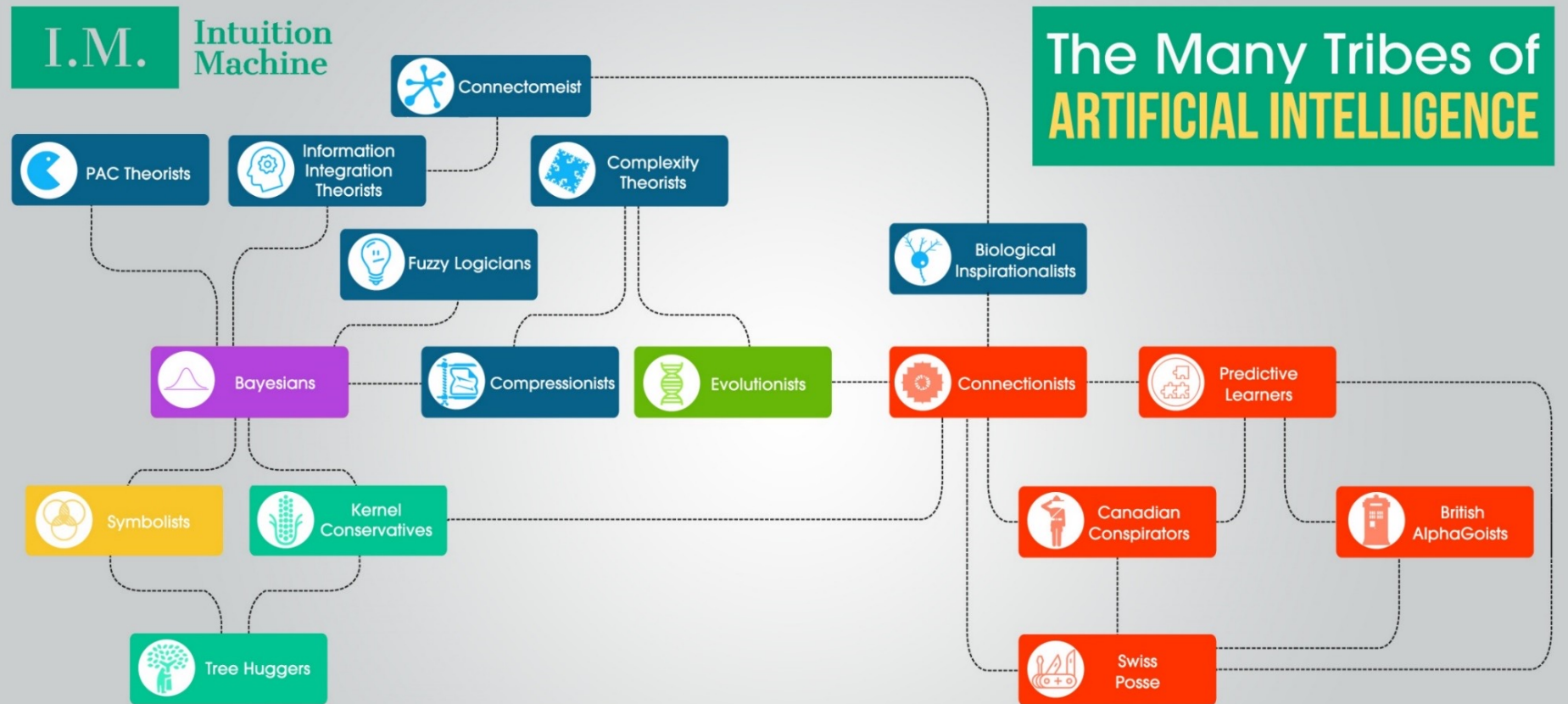
Intelligence is the ability to **learn** or **understand** or to **deal with** new or trying situations;
the ability to apply knowledge to manipulate one's **environment** or to **think** abstractly.

1.1 Brief Review

□ The History of AI



1.2 Different Tribes of AI



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1.2 Brief Review

□ Traditional AI Methods



OUTLINE

- 1.1 Brief Review
- 1.2 *Knowledge Representation & Reasoning*



1.3 Knowledge Representation & Reasoning



- *What is knowledge representation?*
- Propositional Logic
- Predicate Logic
- Production-rule System
- Frame-Based System
- State Space System
- Knowledge graph

1.3 Knowledge Representation & Reasoning

□ Puzzle Time

- An island has two kinds of inhabitants, *knights*, who always tell the truth, and *knaves*, who always lie.
- You go to the island and meet A and B.
 - A says “B is a knight.”
 - B says “The two of us are of opposite types.”

Example: What are the types of A and B?



How to represent the problem and solve it by computer?



Knowledge representation and reasoning

1.3 Knowledge Representation & Reasoning



□ Knowledge

- the information, understanding and skills accumulated in long-term life and social practice, scientific research and experiments.
- An information structure that links related information together.
- Knowledge reflects the relationship between things in the objective world.

Example:

1. The snow is in white. --- Facts
2. If you have a headache and a runny nose, you might have a cold. --- Rule

1.3 Knowledge Representation & Reasoning

□ Characteristic of Knowledge

➤ Relative correctness

Any knowledge is produced under certain conditions, and is correct under such conditions.

$1+1=2$ (decimal system)
 $1+1=10$ (binary system)

1.3 Knowledge Representation & Reasoning

□ Characteristic of Knowledge

- Uncertainty: True, False, state between True and False
- Uncertainty caused by **randomness**
 - Uncertainty caused by **ambiguity**
 - Uncertainty caused by **experience**
 - Uncertainty caused by **incompleteness**

Example:

1. If you have a headache and a runny nose, you **might** have a cold.
2. Li is **very high**.

1.3 Knowledge Representation & Reasoning

□ Characteristic of Knowledge

➤ Uncertainty caused by **ambiguity**



天气冷热



雨的大小



风的强弱



人的胖瘦



年龄大小



个子高低

--- A vague concept

1.3 Knowledge Representation & Reasoning



□ Characteristic of Knowledge

➤ Representability and Exploitability

Representability of knowledge: Knowledge can be expressed in appropriate forms, such as language, writing, graphics, neural networks, etc.

Exploitability of Knowledge : Knowledge can be utilized

1.3 Knowledge Representation & Reasoning



□ Knowledge Representation

- Formalize or model human knowledge.
- a description of knowledge, or a set of conventions, a data structure that a computer can accept to describe knowledge.
- Principles for selecting knowledge representation methods:
 - Fully express domain knowledge.
 - Conducive to the use of knowledge.
 - Easy to organize, maintain and manage
 - Easy to understand and implement.

1.3 Knowledge Representation & Reasoning



- What is knowledge representation?

- *Propositional Logic*

- Production-rule System

- Frame-Based System

- State Space System

- Knowledge graph

1.3 Knowledge Representation & Reasoning

□ What is propositional logic

Proposition:

A := The street is wet.

B := It is raining.

A **proposition** is a statement that is either **true** or **false** but *not both*.

- Atomic formulas are denoted by letters A, B, C, etc.
- Each atomic formula is assigned a truth value: true (1) or false (0).

1.3 Knowledge Representation & Reasoning

□ What is propositional logic

- A *proposition* is a **declarative sentence** that is either true or false.
- Examples of propositions:
 - a) The Moon is made of green cheese.
 - b) Beijing is the capital of China.
 - c) Hangzhou is the capital of Canada.
 - d) $1 + 0 = 1$
 - e) $0 + 0 = 2$
- Examples that are not propositions.
 - a) Sit down!
 - b) What time is it?
 - c) $x + 1 = 2$
 - d) $x + y = z$

1.3 Knowledge Representation & Reasoning



□ What is propositional logic

- It is possible to determine whether any given statement is a proposition by prefixing it with
 - *It is true that . . .*
 - and seeing whether the result **makes grammatical sense.**
- What is the time?
- $2 + 3 = 5$
- “Phone” has five letters.
- $2 + 3 = 6$
- Oh dear!
- I like AI class.

1.3 Knowledge Representation & Reasoning

□ What is propositional logic

- Have a try...

- 您去电影院吗?
- $2 + 3 = 5$
- 看花去!
- 这句话是谎言。
- $X=2$
- 两个奇数之和是奇数。
- 李白要么擅长写诗，要么擅长喝酒。

不是命题

命题

不是命题

不是命题

不是命题

命题

命题

1.3 Knowledge Representation & Reasoning

□ What is propositional logic

Proposition:

A := The street is wet.

B := It is raining.

“Propositional logic is not the study of truth, but of the relationship between the truth of one statement and that of another”
——Hedman 2004



We can connect the two propositions A and B:

If it is raining, the street is wet.



Written more formally

It is raining. \rightarrow The street is wet.

$A \rightarrow B$

1.3 Knowledge Representation & Reasoning


□ What is propositional logic

- Constructing Propositions

- **Propositional Variables:** p, q, r, s, \dots
- The **proposition** that is always true is denoted by **T** and the proposition that is always false is denoted by **F**.
- **Compound Propositions:** constructed from logical connectives and other propositions
 - Negation \neg (否定联结词)
 - Conjunction \wedge (合取联结词)
 - Disjunction \vee (析取联结词)
 - Implication \rightarrow (蕴涵联结词)
 - Biconditional \leftrightarrow (等价联结词)

1.3 Knowledge Representation & Reasoning

□ Syntax of logical connectives

- Conjunction : And \wedge
- Disjunction : Or \vee
- Negation : Not \neg
- Implication : Implies \rightarrow (if... then...)
- Biconditional : Iff  (if and only if)

1.3 Knowledge Representation & Reasoning

□ AND (\wedge)

读作：“A并且B” “A与B”
称为：A与B的合取式
记作： $A \wedge B$

- The *conjunction* ' $A \text{ AND } B$ ', written $A \wedge B$, of two propositions is true **when both A and B are true**, false otherwise.

Translation of sentences to propositions

$A :=$ It's Monday.
 $B :=$ It's raining.

A	B	$A \wedge B$
t	t	t
t	f	f
f	t	f
f	f	f

It's Monday and it's raining.
It's Monday but it's raining.
It's Monday. It's raining.

} $A \wedge B$

1.3 Knowledge Representation & Reasoning

□ Translation of propositions to sentences

- In propositional logic :
- $A \wedge B$ and $B \wedge A$ should always have the same meaning.
- But...
- $A :=$ She became sick .
- $B :=$ she went to the doctor.

Logically the same!

- She became sick and she went to the doctor.
- and
- She went to the doctor and she became sick.

Different!

1.3 Knowledge Representation & Reasoning

□ OR (\vee)

读作: “A或者B”
称为: A与B的析取式
记作: $A \vee B$

- Also called *disjunction*.
- The disjunction “ A OR B ”, written $A \vee B$, of two propositions is true when A or B (or both) are true, false otherwise.

A	B	$A \vee B$
t	t	t
t	f	t
f	t	t
f	f	f

Translation of sentences to propositions

$A :=$ It's Monday.

$B :=$ It's raining.

It's Monday or it's raining. $A \vee B$

1.3 Knowledge Representation & Reasoning

□ NOT

- Also known as *negation*
- The negation “NOT A ” of a proposition (or $\neg A$) is true when A is false and is false otherwise.
- $\neg A$ may be read that it is
- false that A .

读作: “非A”
称为: A的否定式
记作: $\neg A$

A	$\neg A$
t	f
f	t

Translation of sentences to propositions

$A :=$ AI is easy.

It is false that AI is easy.

It is not the case that AI is easy. $\neg A$

AI is not easy.

1.3 Knowledge Representation & Reasoning

□ If ... Then (\rightarrow)

读作：“如果A则B”
称为：A与B的蕴涵式
记作： $A \rightarrow B$

- Also known as **implication**
- The implication “ A IMPLIES B ”, written $A \rightarrow B$, of two propositions is true when either A is false or B is true, and false otherwise.

A:= I study hard.

B:= I get rich.

If I study hard then I get rich.
Whenever I study hard, I get rich.
That I study hard implies I get rich.
I get rich, if I study hard.

} $A \rightarrow B$

A	B	$A \rightarrow B$
t	t	t
t	f	f
f	t	t
f	f	t

1.3 Knowledge Representation & Reasoning

□ If . . . Then (\rightarrow)

- In $p \rightarrow q$ there does not need to be any connection between the antecedent or the consequent.
- The “meaning” of $p \rightarrow q$ depends only on the truth values of p and q .
- These implications are perfectly fine, but would not be used in ordinary English.
 - “If the moon is made of green cheese, then I have more money than Bill Gates. ”
 - “If the moon is made of green cheese then I’m on welfare.”

1.3 Knowledge Representation & Reasoning

□ Different Ways of Expressing $p \rightarrow q$

if p , then q

p implies q

if p , q

p only if q

q unless $\neg p$

q when p

q if p

q whenever p

p is sufficient for q

q follows from p

q is necessary for p

a necessary condition for p is q

a sufficient condition for q is p

1.3 Knowledge Representation & Reasoning

□ Converse, Contrapositive, and Inverse

- From $p \rightarrow q$ we can form new conditional statements .
 - $q \rightarrow p$ is the **converse** of $p \rightarrow q$
 - $\neg q \rightarrow \neg p$ is the **contrapositive** of $p \rightarrow q$
 - $\neg p \rightarrow \neg q$ is the **inverse** of $p \rightarrow q$

Example: Find the converse, inverse, and contrapositive of “It’s raining is a sufficient condition for my not going to town.”

Solution:

converse: ?

inverse: ?

contrapositive: ?

1.3 Knowledge Representation & Reasoning

□ Converse, Contrapositive, and Inverse

- From $p \rightarrow q$ we can form new conditional statements .
 - $q \rightarrow p$ is the **converse** of $p \rightarrow q$
 - $\neg q \rightarrow \neg p$ is the **contrapositive** of $p \rightarrow q$
 - $\neg p \rightarrow \neg q$ is the **inverse** of $p \rightarrow q$

Example: Find the converse, inverse, and contrapositive of
“It’s raining is a sufficient condition for my not going to town.”

Solution: \rightarrow “If it is raining, I do not go town.”

converse: If I do not go to town, then it is raining.

inverse: If it is not raining, then I will go to town.

contrapositive: If I go to town, then it is not raining.

1.3 Knowledge Representation & Reasoning

□ Biconditional

读作: “A当且仅当B”
称为: A与B的等价式
记作: $A \leftrightarrow B$

- Also known as iff or the biconditional.

The biconditional, written as $A \leftrightarrow B$, of two propositions is true when both A and B are true or when both A and B are false, and false otherwise.

A	B	$A \leftrightarrow B$
t	t	t
t	f	f
f	t	f
f	f	t

If p denotes “I am at home.” and q denotes “It is raining.” then $p \leftrightarrow q$ denotes “I am at home **if and only if** it is raining.”

1.3 Knowledge Representation & Reasoning

□ Semantics

- Example:

A := The street is wet.

B := It is raining.

If A is true, and B is true, then $A \wedge B$ is true.

Truth table

A	B	$A \wedge B$
t	t	t
t	f	f
f	t	f
f	f	f

A	B	$\neg A$	$A \wedge B$	$A \vee B$	$A \rightarrow B$	$A \leftrightarrow B$
t	t	f	t	t	t	t
t	f	f	f	t	f	f
f	t	t	f	t	t	f
f	f	t	f	f	t	t

Operator	precedence
\neg	1
\wedge, \vee	2
$\rightarrow, \leftrightarrow$	3

1.3 Knowledge Representation & Reasoning

□ Tautologies, Contradictions, and Contingencies

- A **tautology** (永真式) is a proposition which is always true.
 - Example: $p \vee \neg p$
- A **contradiction** (矛盾式) is a proposition which is always false.
 - Example: $p \wedge \neg p$
- A **contingency** is a proposition which is neither a tautology nor a contradiction, such as p

1.3 Knowledge Representation & Reasoning

□ Logical Equivalences

- Two compound propositions p and q are **logically equivalent** if $p \leftrightarrow q$ is a tautology.
- We write this as $p \leftrightarrow q$ or as $p \equiv q$ where p and q are compound propositions.
- Two compound propositions p and q are equivalent if and only if the columns in a truth table giving their truth values agree.
- This truth table shows that $\neg p \vee q$ is equivalent to $p \rightarrow q$.

p	q	$\neg p$	$\neg p \vee q$	$p \rightarrow q$
T	T	F	T	T
T	F	F	F	F
F	T	T	T	T
F	F	T	T	T

1.3 Knowledge Representation & Reasoning

□ De Morgan's Laws

$$\neg(p \wedge q) \equiv \neg p \vee \neg q$$

$$\neg(p \vee q) \equiv \neg p \wedge \neg q$$



Augustus De Morgan

1806-1871

This truth table shows that De Morgan's Second Law holds.

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

1.3 Knowledge Representation & Reasoning

□ De Morgan's Laws

$$\neg(p \wedge q) \equiv \neg p \vee \neg q$$

$$\neg(p \vee q) \equiv \neg p \wedge \neg q$$



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

1.3 Knowledge Representation & Reasoning

□ De Morgan's Laws

$$\neg(p \wedge q) \equiv \neg p \vee \neg q$$

$$\neg(p \vee q) \equiv \neg p \wedge \neg q$$



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This truth table shows that De Morgan's Second Law holds.

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

1.3 Knowledge Representation & Reasoning

□ De Morgan's Laws

$$\neg(p \wedge q) \equiv \neg p \vee \neg q$$

$$\neg(p \vee q) \equiv \neg p \wedge \neg q$$



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1806-1871

This truth table shows that De Morgan's Second Law holds.

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

1.3 Knowledge Representation & Reasoning

□ De Morgan's Laws

$$\neg(p \wedge q) \equiv \neg p \vee \neg q$$

$$\neg(p \vee q) \equiv \neg p \wedge \neg q$$



Augustus De Morgan

1806-1871

This truth table shows that De Morgan's Second Law holds.

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

1.3 Knowledge Representation & Reasoning

□ Key Logical Equivalences

- Identity Laws: $p \wedge T \equiv p, \quad p \vee F \equiv p$
- Domination Laws: $p \vee T \equiv T, \quad p \wedge F \equiv F$
- Idempotent laws: $p \vee p \equiv p, \quad p \wedge p \equiv p$
- Double Negation Law: $\neg(\neg p) \equiv p$
- Negation Laws: $p \vee \neg p \equiv T, \quad p \wedge \neg p \equiv F$

1.3 Knowledge Representation & Reasoning

□ Key Logical Equivalences

- Commutative Laws: $p \vee q \equiv q \vee p, \quad p \wedge q \equiv q \wedge p$
- Associative Laws: $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$
 $(p \vee q) \vee r \equiv p \vee (q \vee r)$
- Distributive Laws: $(p \vee (q \wedge r)) \equiv (p \vee q) \wedge (p \vee r)$
 $(p \wedge (q \vee r)) \equiv (p \wedge q) \vee (p \wedge r)$
- Absorption Laws: $p \vee (p \wedge q) \equiv p \quad p \wedge (p \vee q) \equiv p$

1.3 Knowledge Representation & Reasoning

□ Logical Equivalences

- *The operations \wedge, \vee are commutative and associative, and the*
- *following equivalences are generally valid:*
- $\neg A \vee B \equiv A \rightarrow B$ (implication)
- $A \rightarrow B \equiv \neg B \rightarrow \neg A$ (contraposition)
- $(A \rightarrow B) \wedge (B \rightarrow A) \equiv (A \leftrightarrow B)$ (equivalence)
- $\neg (A \wedge B) \equiv \neg A \vee \neg B$ (De Morgan's law)
- $\neg (A \vee B) \equiv \neg A \wedge \neg B$
- $A \vee (B \wedge C) \equiv (A \vee B) \wedge (A \vee C)$ (distributive law)
- $A \wedge (B \vee C) \equiv (A \wedge B) \vee (A \wedge C)$
- $A \vee \neg A \equiv t$ (tautology)
- $A \wedge \neg A \equiv f$ (contradiction)
- $A \vee f \equiv A$
- $A \vee t \equiv t$
- $A \wedge f \equiv f$
- $A \wedge t \equiv A$

1.3 Knowledge Representation & Reasoning

□ Logical Equivalences

- *The operations \wedge, \vee are commutative and associative, and the*
- *following equivalences are generally valid:*

- $\neg A \vee B \equiv A \rightarrow B$ (implication)
- $A \rightarrow B \equiv \neg B \rightarrow \neg A$ (contraposition)

A	B	$\neg A$	$\neg A \vee B$	$A \rightarrow B$
t	t	f	t	t
t	f	f	f	f
f	t	t	t	t
f	f	t	t	t

1.3 Knowledge Representation & Reasoning

□ Equivalence Proofs

Example: Show that $\neg(p \vee (\neg p \wedge q))$
is logically equivalent to $\neg p \wedge \neg q$

Solution:

1.3 Knowledge Representation & Reasoning

□ Equivalence Proofs

Example: Show that $\neg(p \vee (\neg p \wedge q))$
is logically equivalent to $\neg p \wedge \neg q$

Solution:

$\neg(p \vee (\neg p \wedge q))$	\equiv	$\neg p \wedge \neg(\neg p \wedge q)$	by the second De Morgan law
	\equiv	$\neg p \wedge [\neg(\neg p) \vee \neg q]$	by the first De Morgan law
	\equiv	$\neg p \wedge (p \vee \neg q)$	by the double negation law
	\equiv	$(\neg p \wedge p) \vee (\neg p \wedge \neg q)$	by the second distributive law
	\equiv	$F \vee (\neg p \wedge \neg q)$	because $\neg p \wedge p \equiv F$
	\equiv	$(\neg p \wedge \neg q) \vee F$	by the commutative law for disjunction
	\equiv	$(\neg p \wedge \neg q)$	by the identity law for F

1.3 Knowledge Representation & Reasoning

□ Equivalence Proofs

Example: Show that $(p \wedge q) \rightarrow (p \vee q)$
is a tautology.

Solution:

1.3 Knowledge Representation & Reasoning

□ Equivalence Proofs

Example: Show that $(p \wedge q) \rightarrow (p \vee q)$
is a tautology.

Solution:

$$\begin{aligned}(p \wedge q) \rightarrow (p \vee q) &\equiv \neg(p \wedge q) \vee (p \vee q) && \text{by truth table for } \rightarrow \\ &\equiv (\neg p \vee \neg q) \vee (p \vee q) && \text{by the first De Morgan law} \\ &\equiv (\neg p \vee p) \vee (\neg q \vee q) && \text{by associative and} \\ &&& \text{commutative laws} \\ &&& \text{laws for disjunction} \\ &\equiv T \vee T && \text{by truth tables} \\ &\equiv T && \text{by the domination law}\end{aligned}$$

1.3 Knowledge Representation & Reasoning



□ Now, we have learned...

- Three basic elements in proposition logic: propositions, operations, and the truth values.
- Logical equivalences

1.3 Knowledge Representation & Reasoning

□ Applications

- 1. Translate English Sentences
- 2. System Specifications
- 3. Logic Puzzles

1.3 Knowledge Representation & Reasoning

□ Example

Problem: Translate the following sentence into propositional logic:
“You can access the Internet from campus **if** you are a computer science major **or** you are not a freshman.”

Atomic propositions:

- $A :=$ You can access the Internet from campus.
- $B :=$ You are a computer science major .
- $C :=$ You are a freshman.

$$(B \vee \neg C) \rightarrow A$$

1.3 Knowledge Representation & Reasoning

□ Example

Problem:

- (1) 除非你很努力，否则你将失败。
- (2) 张三或者李四都可以做这件事。

Atomic propositions:

- (1) $A :=$ 你努力。 $B :=$ 你失败。
- (2) $A :=$ 张三能做事。 $B :=$ 李四可以做这件事。

$$(1) \neg A \rightarrow B$$

$$(2) A \wedge B$$

1.3 Knowledge Representation & Reasoning

□ Consistent System Specifications

- Definition: A list of propositions is consistent if it is possible to assign truth values to the proposition variables so that **each proposition in the list is true.**

1.3 Knowledge Representation & Reasoning



□ Consistent System Specifications

Example: Is this list of propositions consistent?

- “The diagnostic message is stored in the buffer or it is retransmitted.”
- “The diagnostic message is not stored in the buffer.”
- “If the diagnostic message is stored in the buffer, then it is retransmitted.”

1.3 Knowledge Representation & Reasoning

□ Consistent System Specifications

Example: Is this list of propositions consistent?

- “The diagnostic message is stored in the buffer or it is retransmitted.”
- “The diagnostic message is not stored in the buffer.”
- “If the diagnostic message is stored in the buffer, then it is retransmitted.”

P:= “The diagnostic message is stored in the buffer.”

Q:= “The diagnostic message is retransmitted”

$$P \vee Q$$

1.3 Knowledge Representation & Reasoning

□ Consistent System Specifications

Example: Is this list of propositions consistent?

- “The diagnostic message is stored in the buffer or it is retransmitted.”
- “The diagnostic message is not stored in the buffer.”
- “If the diagnostic message is stored in the buffer, then it is retransmitted.”

P:= “The diagnostic message is stored in the buffer.”

Q:= “The diagnostic message is retransmitted”

$\neg P$

1.3 Knowledge Representation & Reasoning

□ Consistent System Specifications

Example: Is this list of propositions consistent?

- “The diagnostic message is stored in the buffer or it is retransmitted.”
- “The diagnostic message is not stored in the buffer.”
- “If the diagnostic message is stored in the buffer, then it is retransmitted.”

P:= “The diagnostic message is stored in the buffer.”

Q:= “The diagnostic message is retransmitted”

$$P \rightarrow Q$$

1.3 Knowledge Representation & Reasoning

□ Consistent System Specifications

Example: Is this list of propositions consistent?

■ “The diagnostic message is stored in the buffer or it is retransmitted.” $P \vee Q$

■ “The diagnostic message is not stored in the buffer.” $\neg P$

■ “If the diagnostic message is stored in the buffer, then it is retransmitted.” $P \rightarrow Q$

P	Q	$P \vee Q$	$\neg P$	$P \rightarrow Q$
t	t			
t	f			
f	t			
f	f			

1.3 Knowledge Representation & Reasoning

□ Consistent System Specifications

Example: Is this list of propositions consistent?

- “The diagnostic message is stored in the buffer or it is retransmitted.”
- “The diagnostic message is not stored in the buffer.”
- “If the diagnostic message is stored in the buffer, then it is retransmitted.”

When P is false and Q is true all three statements are true. So the list of propositions is **consistent**.

P	Q	$P \vee Q$	$\neg P$	$P \rightarrow Q$
t	t	t	f	t
t	f	t	f	f
f	t	t	t	t
f	f	f	t	t

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■ The diagnostic message is not retransmitted. $\neg Q$

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t	t	t	f	t	
t	f	t	f	f	
f	t	t	t	t	
f	f	f	t	t	

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■ The diagnostic message is not retransmitted. $\neg Q$

The list of propositions is
not consistent!

P	Q	$P \vee Q$	$\neg P$	$P \rightarrow Q$	$\neg Q$
t	t	t	f	t	f
t	f	t	f	f	t
f	t	t	t	t	f
f	f	f	t	t	t

1.3 Knowledge Representation & Reasoning

□ Logic Puzzles

Knights: t
Knaves: f

- An island has two kinds of inhabitants, *knights*, who always tell the truth, and *knaves*, who always lie.
- You go to the island and meet A and B.
 - A says “B is a knight.”
 - B says “The two of us are of opposite types.”

Example: What are the types of A and B?

1.3 Knowledge Representation & Reasoning

□ Logic Puzzles

- **Solution:** Let p and q be the statements that **A is a knight** and **B is a knight**, respectively. So, then $\neg p$ represents the proposition that A is a knave and $\neg q$ that B is a knave.
 - If A is a knight, then p is true. Since knights tell the truth, q must also be true. Then $(p \wedge \neg q) \vee (\neg p \wedge q)$ would have to be true, but it is not. So, A is not a knight and therefore $\neg p$ must be true.
 - If A is a knave, then B must not be a knight since knaves always lie. So, then both $\neg p$ and $\neg q$ hold since both are knaves.

Homework-1

□ Logic Puzzles

Knights: t
Knaves: f

- An island has two kinds of inhabitants, *knights*, who always tell the truth, and *knaves*, who always lie.
- You go to the island and meet A and B.
 - A says “At least one of us is a knave.”
 - B says nothing.

Example: What are the types of A and B?