

CSI4106
Introduction to Artificial Intelligence

Course Professor: **Caroline Barrière**

Assignment 3: Reasoning in Humans and AI

Group 67

Team Members:

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Due Date: Nov 12th

Q1. Propositional logic and proofs

Choose I, J, K, L

i. let $Q \rightarrow R$ be A

1. $P \rightarrow A$ Premise
2. $\neg A$ Premise
3. $\neg P$ Modus Tollens (1, 2)

The value of Q, R does not matter in this case because consider it as entity and $\neg P$ always stands.

j.

1. $\neg(Q \rightarrow R) \rightarrow P$ Premise
2. $\neg P$ Premise
3. Q Premise
4. $\neg \neg(Q \rightarrow R)$ Modus tollens (1, 2)
5. $Q \rightarrow R$ Double negation (4)
6. R Modus ponens (3, 5)

k.

1. P Premise
2. $P \rightarrow R$ Premise
3. $(P \rightarrow (R \rightarrow Q))$ Premise
4. R Modus ponens (1, 2)
5. $R \rightarrow Q$ Modus ponens (1, 3)
6. Q Modus ponens (4, 5)

L.

1. $\neg R$ Premise
2. $S \rightarrow R$ Premise
3. P Premise
4. $(P \rightarrow (T \rightarrow S))$ Premise
5. $\neg S$ Modus tollens (1, 2)
6. $T \rightarrow S$ Modus ponens (3, 4)
7. $\neg T$ Modus tollens (5, 6)

Question 2. Predicate logic

Express the statements in predicate logic: $\exists \forall$

1. All graduate students have an undergraduate degree.

$\forall x: \text{GraduateStudent}(x) \rightarrow \text{UndergraduateDegree}(x)$

2. Anyone with an undergraduate degree studied in at least one university.

$\forall x \exists y: \text{UndergraduateDegree}(x) \rightarrow \text{StudiedAt}(x, y)$

3. A university, at any particular year, delivers courses to many students.

$\forall x \forall y \forall z: (\text{University}(x) \wedge \text{Year}(y) \wedge \text{StudentInUniversity}(z) \wedge \text{DeliversCoursesTo}(x, y, z))$

4. For a professor to teach a course, there must be at least a student registered in it.

$\forall x \forall y \exists z: (\text{Teach}(x, y) \rightarrow \text{Registered}(x, y, z))$

5. A class is called a large class if at least 100 students are part of it.

$\forall x: \text{MoreThan100Student}(x) \rightarrow \text{LargeClass}(x)$

6. Classmates are students taking the same course.

$\forall x \forall y: \text{Student}(x) \wedge \text{Student}(y) \wedge \text{SameCourse}(x, y) \rightarrow \text{Classmate}(x, y)$

7. A graduate student takes less courses than an undergraduate student

$\forall x \forall y: \text{GraduateStudent}(x) \wedge \text{UndergraduateStudent}(y) \rightarrow \text{LessCourse}(x, y)$

Question 3. Fuzzy Logic

1. define linguistic variable

Sleep: subset {light, deep, REM (rapid eye movement)}

- Range: 1 to 10

- Fuzzy Subsets:

Light: 1-4

Deep: 4-8

REM: 6-10

Leisure: subset {Low, Moderate, High, Abundant}

- Range: 0 to 10

- Fuzzy Subsets:

Low: 0-4

Moderate: 3-6

High: 5-8

Abundant: 7-10

Stress: subset {Low, Moderate, High, V}

- Range: 2 to 10

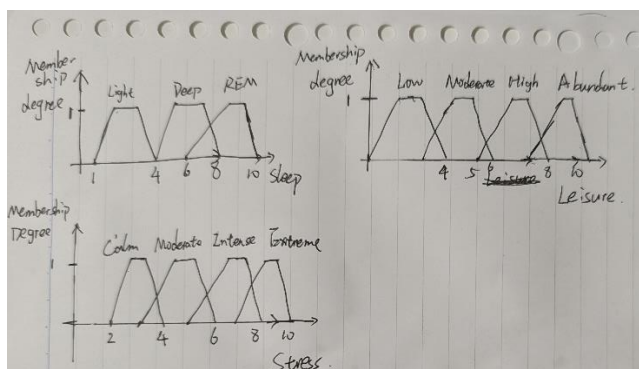
- Fuzzy Subsets:

Calm: 2-4

Moderate: 3-6

Intense: 5-8

Extreme: 7-10



2. Fuzzy Rules

- i. IF Stress is Calm AND Leisure is Abundant THEN Sleep quality is REM
- ii. IF Stress is Intense OR Leisure is Low THEN Sleep quality is Light
- iii. IF Stress is Moderate AND Leisure is Moderate THEN Sleep quality is Deep

3. Fuzzy Inference

Step 1.

Input: Stress = 5.5 and Leisure = 5

- Stress Level: Calm: 0, Moderate: 0.87, Intense: 0.32, Extreme: 0
- Leisure Time: Low: 0, Moderate: 0.8, High: 0, Abundant: 0

Step 2.

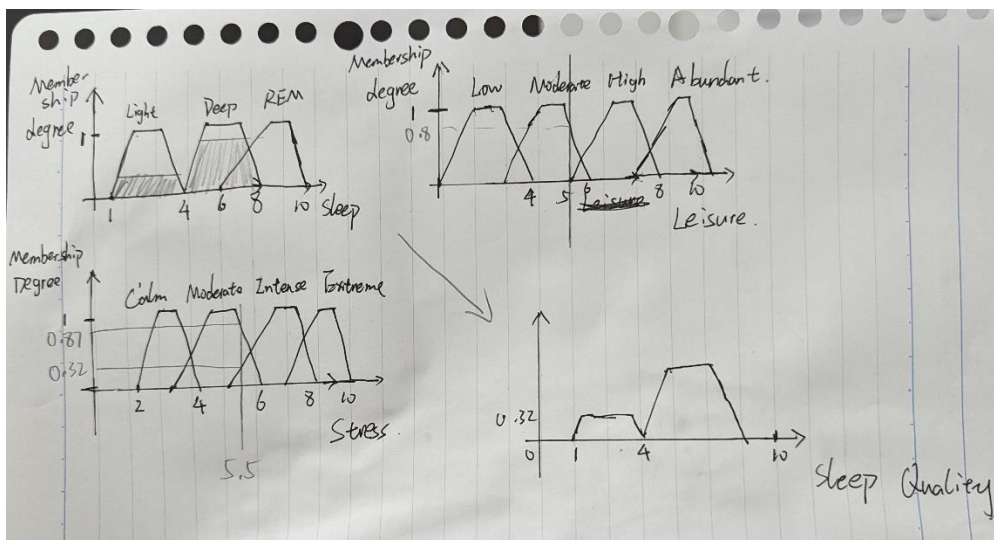
Rule 1. $\min(0,0) = 0$

Rule 2. $\max(0.32,0) = 0.32$

Rule 3. $\min(0.87,0.8) = 0.8$ (Deep)

Step 3. Transfer the resulting membership degree on the consequence

Rule 1 returns the result of 0, there will be no part for REM.



Question 4. Reasoning

Constraint-based reasoning

Reference: <https://www.examsbook.com/reasoning-ability-questions-and-answers/2>

Q.13. In a certain code language,

'134' means 'good and tasty';

'478' means 'see good pictures';

'729' means 'pictures are faint'.

Which of the following digits stands for 'see'?

(A) 9

(B) 2

(C) 1

(D) 8

This is a good example because it requires identifying the relationship between the digits and the corresponding words in the given constraints.

Other type of Reasoning intertwined: the problem involves deductive reasoning because the process is similar to deduction.

Solution:

From first and second sentence we know that only '4' and 'good' occur, so we know that 4 is good, same reason for '7' is "pictures". Therefore, only left in second sentence is 'see' and 8 so 'see' is 8.

Require knowledge: Ability to decrypt the message base on the relationship between digit and alphabet and understanding of pattern recognition.

Specific: Recognizing that in this particular code, the digit '4' stands for 'see'.

Generic: Understanding the general concept of pattern recognition, which can be applied to similar problems involving coded messages.

Inductive reasoning

Reference: <https://www.examsbook.com/reasoning-ability-questions-and-answers/1>

Q4. A, B, N, C, D, O, E, F, P, ?, ?, ?

- (A) G, H, I
- (B) G, H, J
- (C) G, H, Q
- (D) J, K, L

This is a good example of inductive reasoning because it involves the process of finding the special cases → finding the pattern of the sequence → Apply to new case

Other type of reasoning involves Alphabet reasoning and deductive reasoning because it requires to find the pattern of alphabet.

Solution:

A, B are consecutive alphabets followed by N. Next three character are C, D, O, where C is followed by B in order and O is followed by N in order. The pattern is first two consecutive letters followed by another letter then start next sequence with same pattern.

Apply the rule to E, F, P also works, so the answer is G, H, Q.

Required knowledge: pattern recognition.

Specific: Recognizing the specific pattern in this sequence to determine the next elements.

Generic: Applying general knowledge of alphabetical order and pattern recognition that can be used in similar problems involving letter sequences.

Analogical reasoning

Reference: <https://www.examsbook.com/reasoning-ability-questions-and-answers/2>

Q.15. Vaunt : Flaunt :: Disparate : ?

- (A) Similar
- (B) Homogenous
- (C) Contrast
- (D) Alike

This is a good example of analogical reasoning as it requires recognizing the relationship between the first pair and applying the same relationship to identify the correct term for the second pair.

This problem may involve deductive reasoning, as the individual needs to deduce the relationship between "disparate" and the correct term based on the analogy presented.

Solution:

Understand the relationship between "vaunt" and "flaunt." Then apply the same relationship to determine the term that relates to "disparate" in a similar way, which is Contrast.

Required Knowledge:

Vocabulary knowledge: understanding the meanings of "vaunt," "flaunt," and "disparate." (lexical knowledge).

Specific: Recognizing the specific relationship between "vaunt" and "flaunt" and applying it to "disparate."

Generic: Applying general knowledge of word relationships and analogies to solve similar problems.

Temporal reasoning

Reference: <https://www.examsbook.com/critical-reasoning-questions-and-answers-for-competitive-exams/1>

Q.4. If it was Friday on 3rd date of a month, then which day would come on the 4th day after 21st date of that month?

- (A) Tuesday
- (B) Monday
- (C) Thursday
- (D) Sunday

This problem is a good example of temporal reasoning because it requires to navigate and reason about the temporal aspects of a calendar and temporal reasoning involves understanding the relationships between different points in time, such as days, and weeks.

This problem also involves mathematical reasoning, as it requires calculation of the right date.

Solution:

3rd → Friday, 7 days a week, $3^{\text{rd}} + 7 \times 3 = 24^{\text{th}}$, which is also Friday.

The forth date after 21st is 25th, which is Saturday.

Required knowledge:

Recognize the regular pattern of days in a week (7 days).

Calculate the number of days between the 21st and the desired date (25th).

Specific: Knowing that there are seven days in a week and understanding the pattern of days repeating.

Generic: The ability to apply the concept of a regular week cycle to any month or year, making it transferable to similar problems involving days of the week.

Spatial reasoning

Reference: <https://www.examsbook.com/reasoning-ability-questions-and-answers/4>

Q.32. In an Exhibition seven cars of different companies - Cadillac, Ambassador, Fiat, Maruti, Mercedes, Bedford and Fargo are standing facing to east in the following order:

1. Cadillac is next to right of Fargo.
2. Fargo is fourth to the right of Fiat.
3. Maruti car is between Ambassador and Bedford.
4. Fiat which is third to the left of Ambassador, is at one end.

Which of the cars are on both the sides of Cadillac car?

- (A) Ambassador and Maruti (B) Maruti and Fiat (C) Fargo and Mercedes
(D) Ambassador and Fargo

This is a good example of spatial reasoning as it involves deducing the positions of the cars in the exhibition based on a set of conditions.

This problem also involves constrain-based reasoning, as the relationships are described with specific constraints that need to be considered while determining the positions of the cars.

Solution:

Draw a floor plan of each car position based on the conditions

1. C is on the right of FA
2. Fiat is on the left of FA, and forth location
3. Go to condition 4, A is just on the left of FA based on the
4. Go to condition 3 the two rest are B and M, B is on the left
5. Only Mercedes left, since Fiat is at the end of one side, the only position for Mercedes is at the other end.

Therefore, the position of all cars is:

Fiat, Bedford, Maruti, Ambassador, Fargo, Cadillac, Mercedes

The answer is C.

Required Knowledge:

Basic deductive reasoning skills.

Ability to visualize and reason about spatial arrangements.

Specific: Applying the given conditions to deduce the specific positions of the cars in the exhibition.

Generic: Applying general principles of spatial reasoning and problem-solving that can be used in similar problems.

Question 5. Causal fallacies

Glittering generality

Reference: <https://propagandafoodcomms9.weebly.com/glittering-generality.html>

“Things go better with Coke”

This advertisement is a good example of glittering generality because “better” can not be defined and has no specific meaning.

Card Stacking

Reference: <https://www.vanityfair.com/style/2013/09/burger-king-s-satisfries-are-the-best-thing-since-sliced-potatoes-deep-fried-in-vegetable-oil>



This propagation is good example of card stacking, it provides couple information like 40% fat and 30% calories less but not the fact that fries are still unhealthy due to high level of fat.

Bandwagon

Reference: <https://www.facebook.com/simsr.interface/posts/the-bandwagon-appeal-is-one-of-roughly-twenty-advertising-appeals-the-bandwagon-/2361136113920874/>



This advertisement is a good example of bandwagon as it said “over a million Australians have already tried ORAL-B toothpastes”. It attempts to encourage the target audience to use the product so that they don’t feel being left out.

2 examples from the lecture:

Weak analogy

Reference: <https://helpfulprofessor.com/false-analogy-examples/>

“Every year more people die in car crashes than in plane crashes. You will be much safer if a plane crashes.”

This is a good example of weak analogy because it draws an invalid comparison between two different situations. The overall risks and circumstances surrounding car crashes and plane crashes differ significantly (Number of use of car as transportation is way much than plane).

Appeal to Ignorance

Reference: <https://www.txst.edu/philosophy/resources/fallacy-definitions/appeal-to-ignorance.html>

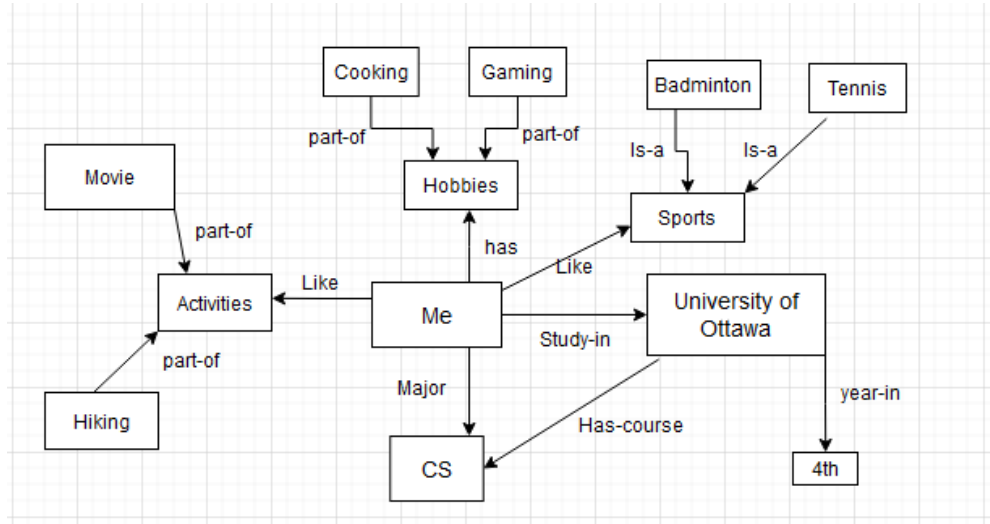
“I guess I didn't get the job. They never called me back.”

In this example, the person is drawing a conclusion based on the absence of a specific event and lack of evidence of being rejected. This fits the fallacy of appeal to Ignorance.

Question 6. Knowledge representation

Link to the graph (PDF version):

<https://drive.google.com/file/d/1DzPFleoKmYZa0RJYUi1k9fwcoMXOfuFz/view>



Q7 – ChatGPT’s reasoning capabilities

Reasoning Chosen and test case

Causal Reasoning:

Alice forgets her password; she won’t be able to login to her account.

Mathematical reasoning:

What is the number of ‘?’ in the following sequence: 1, 2, 3, 10, ?, 9802

Analogical reasoning:

Amnesia : Memory : : Paralysis : ?

(A) Movement (B) Limbs (C) Handicapped (D) Legs

Deductive reasoning:

All noble gases are stable. Helium is a noble gas, so helium is stable.

Temporal Reasoning:


The bus is coming at 9:15am, and it takes 30 minutes for Alice to get to the station, when should Alice start to go to the station?

Test result:

Causal Reasoning: almost success

WE


I will give you some test, you need to describe what reasoning type of the test is and why



Sure, I'd be happy to help you analyze and identify the reasoning type of the test. Please provide the details of the test, and I'll do my best to describe the reasoning type and explain the underlying logic.

WE

Alice forgets her password; she won't be able to login to her account.




The statement "Alice forgets her password; she won't be able to log in to her account" also involves conditional reasoning. Specifically, it follows a cause-and-effect relationship where forgetting the password is the cause, and the effect is the inability to log in.

In logical terms, this can be expressed as a causal relationship: "Forgetting the password causes the consequence of being unable to log in."

The reasoning type is again deductive, as the conclusion logically follows from the given cause-and-effect relationship. This type of reasoning is common in everyday situations and is often used to explain the consequences of specific actions or events.

WE

Alice forgets her password; she won't be able to login to her account.






The statement "Alice forgets her password; she won't be able to log in to her account" is also an example of deductive reasoning. It follows a cause-and-effect relationship where the premise (Alice forgetting her password) directly leads to the conclusion (she won't be able to log in). In this case, the conclusion logically follows from the given premise, and the reasoning is deductive.

Mathematical reasoning: Almost Success

What is the number of '?' in the following sequence: 1, 2, 3, 10, ?, 9802, what is the reasoning type and why?

The sequence seems to follow a pattern where each number is obtained by raising the previous number to the power of 2 and then subtracting 1:







- $2^1 - 1 = 1$
- $2^2 - 1 = 3$
- $2^3 - 1 = 7$
- $2^4 - 1 = 15$


Following this pattern, the next number would be $2^5 - 1 = 31$.

So, the completed sequence is: 1, 2, 3, 7, 15, 31, 9802.

The reasoning type here is inductive reasoning because we are identifying a pattern based on observed examples and using it to make predictions about future examples in the sequence. We're not proving a general rule, but we are inferring a pattern that appears to hold in this specific sequence.

Regenerate





To identify the pattern in the sequence, let's examine the differences between consecutive terms:

1. The difference between 2 and 1 is 1.
2. The difference between 3 and 2 is 1.
3. The difference between 10 and 3 is 7.

The differences appear to be increasing by multiples of 6. Specifically, $1 \times 6 = 6$ and $7 \times 6 = 42$.

Now, let's continue this pattern:

1. To find the next difference, we add 6×6 to the previous difference: $42 + 6 \times 6 = 78$.

So, the differences between consecutive terms are 1, 1, 7, 78. The next difference, following the pattern, would be $78 + 6 \times 6 \times 6 = 294$.

Now, let's find the missing term:

$$10 + 294 = 304$$

Therefore, the sequence is 1, 2, 3, 10, 304, 9802, and there are two "?" in the sequence.

The reasoning type for this sequence is based on a specific mathematical formula governing the differences between terms. This type of reasoning is best described as pattern-based or mathematical reasoning, where there is a consistent mathematical rule governing the progression from one term to the next.

Analogical reasoning: Success

Amnesia : Memory :: Paralysis : ?
(A) Movement (B) Limbs (C) Handicapped (D) Legs

The relationship between "Amnesia" and "Memory" appears to be a cause-and-effect relationship. Amnesia is a condition that affects or impairs memory. Therefore, we need to find a similar cause-and-effect relationship for "Paralysis."

The correct analogy is:

(A) Movement : Paralysis

Just as amnesia affects memory, paralysis affects movement. So, the correct answer is (A) Movement.

Amnesia : Memory :: Paralysis : ?
(A) Movement (B) Limbs (C) Handicapped (D) Legs

In this analogy, "Amnesia" is related to "Memory" in a way similar to how "Paralysis" is related to one of the options.

Amnesia is a loss of memory. Similarly, paralysis is a loss or impairment of the ability to move muscles in the body.

Therefore, the correct answer is (A) Movement. The relationship between the pairs is that the first term represents a loss or impairment of a certain function, and the second term represents the specific function affected. In this case, amnesia affects memory, and paralysis affects movement.

so what type of reasoning is it

The reasoning type in this analogy is based on a relationship of cause and effect or a characteristic associated with a condition. Specifically, it's a type of associative reasoning where you are asked to identify the relationship between two terms and then apply the same relationship to find the corresponding term in the second pair. In this case, the relationship is one of loss or impairment and the specific function affected.

so what type of reasoning is it

The type of reasoning in this analogy is classification or categorization. It involves recognizing the relationship between pairs of words and selecting the option that best fits the pattern established by the given pair. In this case, the relationship is based on a type of loss or impairment (amnesia:memory) and finding the equivalent loss or impairment in the answer choices (paralysis:movement). This falls under the category of verbal analogy reasoning.

Deductive reasoning: Success

All noble gases are stable. Helium is a noble gas, so helium is stable.


The reasoning in this statement is deductive reasoning. Deductive reasoning is a form of logical thinking where conclusions are drawn from given premises or statements. In this case:

1. All noble gases are stable (premise).
2. Helium is a noble gas (premise).

Therefore, based on these premises, the conclusion is drawn:

1. Helium is stable.

The conclusion logically follows from the given premises, making it an example of deductive reasoning.

 All noble gases are stable. Helium is a noble gas, so helium is stable.




The reasoning in this argument is deductive reasoning. It uses a general principle about noble gases (that all noble gases are stable) and applies it to a specific case (helium is a noble gas) to draw a logical conclusion (helium is stable). The conclusion is derived directly from the premises, making it a deductive argument. If the premises are true, the conclusion must also be true.




Temporal Reasoning: not success not fail

WE

The bus is coming at 9:15am, and it takes 30 minutes for Alice to get to the station, when should Alice start to go to the station? what reasoning type is it?



The reasoning involved in determining when Alice should start to go to the station is based on simple arithmetic or time calculation. It's a practical application of deductive reasoning.

Here's the breakdown:

1. The bus is coming at 9:15 am.
2. It takes 30 minutes for Alice to get to the station.


Therefore, to find out when Alice should start going to the station, you deduct the travel time from the bus arrival time:

$$9 : 15 \text{ am} - 0 : 30 \text{ hr} = 8 : 45 \text{ am}$$

So, Alice should start going to the station at 8:45 am.

WE

The bus is coming at 9:15am, and it takes 30 minutes for Alice to get to the station, when should Alice start to go to the station? what reasoning type is it?



The reasoning involved here is time calculation or scheduling. To determine when Alice should start to go to the station, you need to consider the time the bus is coming (9:15 am) and the time it takes for Alice to get to the station (30 minutes).

In this case, you would subtract the travel time from the bus arrival time to find the time Alice should start:

$$9 : 15 \text{ am} - 30 \text{ minutes} = 8 : 45 \text{ am}$$

Therefore, Alice should start to go to the station at 8:45 am.

Result analysis:

There can be more than one type of reasoning intertwined for a question, so GPT can return two different answers but both of them is reasonable. However, sometime it returns the wrong one like the mathematical reasoning question. It can not find the correct answer (the pattern is too complicated).

ChatGPT can perform most of the test. Whether the answer is true or false still need to be judged by human beings.