



Artificial Intelligence and Machine Learning (CS52)

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Unit 2 - Problems

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1. Determine the validity of the following argument using propositional logic

- a. "If most people believe that artificial intelligence will eventually replace most jobs, then it's true. We should therefore prepare for an economy where very few jobs exist, and everyone receives a basic income."
- b. "All scientists who have won Nobel Prizes are highly skilled in their fields. Dr. Smith is highly skilled in her field. Therefore, Dr. Smith must have won a Nobel Prize." Is this argument valid or invalid? Explain why the conclusion may or may not follow from the premises.
- c. "Since stricter gun control laws were introduced in a neighboring country, the crime rate dropped significantly. Therefore, implementing the same laws here will lead to the same result." Analyze whether this argument is valid. Does it appropriately infer causation?
- d. "Studies show that people who meditate daily have lower stress levels. Therefore, to reduce stress, everyone should meditate daily." Assess the argument's validity. Does this conclusion logically follow from the
- e. "If the company does not innovate, it will lose its competitive edge. If it loses its competitive edge, it will lose customers. If it loses customers, it will eventually go bankrupt. Therefore, if the company does not innovate, it will go bankrupt." Determine if this argument is valid or if it makes unwarranted assumptions along the chain.
- f. "When John skipped breakfast, he felt tired throughout the day. So, skipping breakfast always leads to tiredness." Is this a valid argument? Explain why one instance may or may not be enough to generalize a cause-effect relationship.
- g. "If the team works overtime, they will finish the project on time. The team worked overtime. Therefore, they finished the project on time." Examine the argument's validity. Is working overtime necessarily sufficient to guarantee project completion on time?
- h. "I know that the source I used is reliable because the information it provided was accurate, and accurate information always comes from reliable sources." Identify if the reasoning here is valid or if it contains a subtle circularity.
- i. "Both the government and a family need to live within their means. If a family shouldn't spend more than it earns, neither should the government." Is this argument valid? Evaluate if the analogy between government and family spending is logically sound.
- j. "People have believed in astrology for thousands of years, so there must

be some truth to it." Does the argument's premise validly support the conclusion? Explain why popularity or longevity might not establish truth.

- k. "Scientists have yet to find evidence of life on other planets. Therefore, life does not exist elsewhere in the universe."

2. Convert the following to Conjunctive Normal Form (CNF)

- Convert $(A \vee (B \wedge C)) \Rightarrow (\neg D \vee E)$ to CNF.
- Transform $(A \vee (B \wedge (C \vee \neg D))) \wedge (\neg E \Rightarrow F)$ into CNF.
- Convert $((A \Rightarrow B) \wedge (C \Rightarrow D)) \vee (E \wedge F)$ into CNF.
- Express $\neg((A \wedge B) \vee (C \wedge (D \vee \neg E)))$ in CNF.
- Convert $\forall x((P(x) \vee Q(x)) \Rightarrow R(x))$ to CNF, assuming quantifiers are allowed and can be brought into CNF form.

2. Write the following statements in Propositional Logic

1. Basic Translation

Write the following statements in propositional logic:

- "If it is raining, then the ground is wet."
- "The sun is shining or it is cloudy."
- "I will go to the party if my friend goes to the party."

2. Negation

Convert the following statements into propositional logic, then write the negation:

- "It is not true that I have both homework and chores to do."
- "If I study, I will pass the exam."

3. Simple AND/OR Statements

Translate these statements:

- "The library is open, and I have my library card."
- "I will go hiking or go to the beach."

4. Combining AND, OR, and Implication

Write the following statements in propositional logic:

- "If it is raining or snowing, then I will stay home."
- "I will go to the concert if and only if my favorite band is playing."
- "If I am not busy, then I will either go for a walk or read a book."

5. Nested Statements

Translate these statements into propositional logic:

- "If it is sunny, I will go to the park and play soccer, but if it rains, I will stay home."
- "I will go to the museum if either it is a rainy day or my friend wants to go."

6. Contrapositive Form

Write the contrapositive of these statements in propositional logic:

- "If I have coffee, then I am awake."

- "If the traffic is heavy, I will be late to work."

7. **Complex Conditional and Biconditional Statements**

Translate the following statements into propositional logic:

- "If I pass the exam, then I will graduate, and if I graduate, then I will apply for a job."
- "If it rains, then I will take an umbrella. If it does not rain, I will go to the beach. Therefore, if I don't take an umbrella, I will go to the beach."

8. **Multiple Nested Clauses**

Write these statements in propositional logic:

- "If I study hard, then either I pass the test or I get extra credit, but if I don't study, I will fail."
- "If I exercise or eat healthy, then I will feel good, but if I don't exercise and I don't eat healthy, I will not feel good."

9. **Expressing Real-World Scenarios in Logic**

Write the following in propositional logic, using letters to represent propositions where needed:

- "I will go out for dinner if it's Friday or Saturday, but if it's Sunday, I will stay home."
- "If the machine is on and there is power, it will work. However, if either the machine is off or there is no power, it won't work."

10. **Use of Logical Equivalence**

Express these statements in propositional logic and rewrite them using logical equivalences:

- "Either I will visit my friend or I will go to the movies, but not both."
- "I will succeed only if I work hard, but working hard does not guarantee success."

4. Solve the following using First Order Logic :

1. **Basic Translation**

- **Question:** Translate the following statement into first-order logic: "All humans are mortal."

2. **Existential Quantifier**

- **Question:** Translate "There exists a student who loves math" into first-order logic.

3. **Simple Negation**

- **Question:** Express "Not all birds can fly" in first-order logic.

4. **Conditional Statements with Quantifiers**

- **Question:** Express "If someone is a student, then they must study" in first-order logic.

5. **Combination of Quantifiers**

- **Question:** Write "Every person has a friend" in first-order logic.



6. Negation of Statements with Quantifiers

- **Question:** Write the negation of "Everyone likes at least one movie."

7. Nested Quantifiers with Implication

- **Question:** Express "Every parent loves all their children" in first-order logic.

8. Expressing Uniqueness with Quantifiers

- **Question:** Translate "There is exactly one President" into first-order logic.

9. Complex Real-World Scenario

- **Question:** Write "Every teacher has at least one student who respects them" in first-order logic.

10. Mutual Exclusivity

- **Question:** Express "No one can be both a student and a professor" in first-order logic.