Artificial Intelligence

Assignment 1

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1 Limits of current AIs (6 Points)

Pick a chat bot of your choice. I would advise ChatGPT, because it makes this exercise most interesting, but any one will do. Find a question that the chat bot answers confidently but incorrectly. State both question and answer. Explain how you came up with your question, what the chat bot did wrong, and what you believe to be the reason why the chat bot failed.

Solution:

Question: How many hearts do octopuses have?

Chatbot: Octopuses have three hearts.

Explanation: I chose this question because it is a common misconception that octopuses have three hearts. However, the correct answer is that they have one heart and two additional accessory hearts. The reason why the chatbot may have failed to provide the correct answer could be that it was programmed with inaccurate or incomplete information. It's important to note that chatbots are only as good as the data they are trained on, and they may not always have access to the latest and most accurate information.

2 Modeling in propositional logic (10 Points)

Assume the following propositions:

- A = “Alice visits the party“
- B = “Bob visits the party“
- C = “Charlie visits the party“
- D = “Daniel visits the party“

Formulate the following sentences in propositional logic over the signature $\mathrm{At} = \{A, B, C, D\}$:

a) Alice visits the party and Bob doesn’t.

b) Daniel and Bob visit the party if and only if Charlie also visits the party.

c) If Alice and Bob visit the party, then Charlie does as well—but only if Daniel is not visiting the party.

d) Charlie visits the party if and only if not both Bob and Alice visit the party, or at least Daniel visits the party.

e) If Alice visits the party, then Bob and Charlie do as well—if Alice does not visit the party, then Charlie and Daniel visit the party.

Solution:

a. A Λ ¬B

b. (D Λ B) ⇔ C

c. (A Λ B) => (C => ¬D)

d. C ⇔(¬ (B Λ A) V D)

e. (A => (B Λ C)) Λ (¬A => (C Λ D)

3 Reasoning in propositional logic (14 Points)

Let $\mathrm{At} = \{P, Q, R\}$ be a propositional signature. Determine which of the following for- mulas are valid and/or satisfiable and/or unsatisfiable. Justify your answer, e.g. using interpretations or equivalences.

(1) $(P \wedge Q) \Rightarrow (P \vee Q)$

(2) $(P \vee Q) \Rightarrow (P \wedge Q)$

(3) $\neg(P \wedge \neg\neg P)$

(4) $Q \Rightarrow \neg Q$

(5) $Q \wedge \neg Q$

(6) $\neg(\neg P \vee \neg\neg P)$

(7) $(P \Rightarrow Q) \wedge (\neg P \Rightarrow R) \Rightarrow (Q \vee R)$

Solution:

1. $(P \wedge Q) \Rightarrow (P \vee Q)$

P	Q	P ∧ Q	P ∨ Q	(P ∧ Q) ⇒ (P ∨ Q)
T	T	T	T	T
T	F	F	T	T
F	T	F	T	T
F	F	F	F	T

(P ∧ Q) ⇒ (P ∨ Q) is true (T) for all possible truth assignments to P and Q. The proposition formula is **valid**. The proposition formula is also **satisfiable** because it is true for at leastone truth assignment.

2. $(P \vee Q) \Rightarrow (P \wedge Q)$

P	Q	P ∨ Q	P ∧ Q	(P ∨ Q) ⇒ (P ∧ Q)
T	T	T	T	T
T	F	T	F	F
F	T	T	F	F
F	F	F	F	T

The proposition formula is **not valid** because **(P ∨ Q) ⇒ (P ∧ Q)** is not True for all truth assignments. However, it is **satisfied** since it is true for some truth assignments to Pand Q.

3. $\neg(P \wedge \neg\neg P)$

P	¬¬P	P ∧ ¬¬P	¬(P ∧ ¬¬P)
T	T	T	F
F	F	F	T

The proposition formula **¬(P ∧ ¬¬P)** is True for some truth assignments to P and false (F)for others. So, the proposition formula is **satisfiable** but **not valid**.

4. Q⇒¬Q

Q	**¬Q**	**Q ⇒ ¬Q**
T	F	F
F	T	T

The proposition formula **Q ⇒ ¬Q** is False when Q is true and True when Q is false. So, the proposition formula is **not valid**. However, the proposition formula is **satisfied** when Q is false. But, the proposition formula is not satisfied when Q is true, as the implication is
false in this scenario.

5. Q∧¬Q

Q	**¬Q**	**Q ∧ ¬Q**
T	F	F
F	T	F

The proposition formula **Q ∧ ¬Q** is False for all possible truth assignments to Q, the proposition formula is **not satisfied**. It can also not be true in any circumstances so it is **not valid**.

6. ¬(¬P ∨¬¬P)

P	**¬P**	**¬¬P**	**¬P ∨ ¬¬P**	**¬(¬P ∨ ¬¬P)**
T	F	T	T	F
F	T	F	T	F

The proposition formula **¬(¬P ∨ ¬¬P)** is True for all possible truth assignments to P, theproposition formula is **valid**. The proposition formula is **satisfied** when P is true.

7. (P ⇒Q)∧(¬P ⇒R)⇒(Q∨R)

P	**Q**	**R**	**P ⇒ Q**	**¬P**	**¬P ⇒ R**	**Q ∨ R**	**(P ⇒ Q) ∧ (¬P ⇒ R)**	**(P ⇒ Q) ∧ (¬P ⇒ R) ⇒ (Q ∨ R)**
T	T	T	T	F	T	T	T	T
T	T	F	T	F	F	T	F	T
T	F	T	F	F	T	T	F	T

T	F	F	F	F	F	F	F	T
F	T	T	T	T	T	T	T	T
F	T	F	T	T	T	T	T	T
F	F	T	T	T	T	T	T	T
F	F	F	T	T	T	F	T	T

The proposition formula **(P ⇒ Q) ∧ (¬P ⇒ R) ⇒ (Q ∨ R)** is True for all possible truth assignments, and so the proposition formula is **valid**.The proposition formula is**satisfied** under all possible truth assignments to P, Q, and R.

Important hints

- Always include all names of all group members that helped solving the excercises **on your PDF**. Only those will receive points for solving the excercises.
- By handing in this sheet, you confirm that you solved these excercises yourself. If the situation occurs that two groups have identical solutions, both groups will get zero points.
- Your SVN-Repositories can be accessed via

  https://svn.uni-koblenz.de/westteaching/ai23/

  followed by your group name. SVNs will be available from 28.04. onwards.
- **Format:** All solutions must be contained in PDF documents (including source code). Additionally, source code must be provided as plain files that are readable via a standard text editor.
- Please make sure that all your programs can be run without errors. Comments on your souce code will be in the annotated PDF that we create during excercise corrections.
- Do not use any mutated vowels or special characters in your source code. Also, do not use those or spaces in file names.