**CSE112 Artificial Intelligence**， **Week 8 2019**

# Exercises and Tutorial Questions

Q1 . Which of the following are well formed propositional formulas?

1. pq

2. (¬ (p  (q  p)))

3. (¬(p  (q p)))

4. (p  ¬q)  (q  r)

1. p¬r

**Q2.** Let’s consider the interpretation v where v(p) = F, v(q) = T, v(r) = T. Does v satisfy the following propositional formulas?

T 1. (p → ¬q) ∨ ¬(r ∧ q)

F 2. (¬p ∨ ¬q) → (p ∨ ¬r)

T 3. ¬(¬p → ¬q) ∧ r

T 4. ¬(¬p → q ∧ ¬r)

**Q3.** Compute the truth table of (F ∨ G) ∧ ¬(F ∧ G).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| F | G | (F ∨ G) | ¬(F ∧ G) | (F ∨ G) ∧ ¬(F ∧ G) |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 |

**Q4.** Use the truth tables method to determine whether (p → q) ∨ (p → ¬q) is valid.

(note: a sentence is valid if it is satisfied by every interpretation. More to explain next week)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | (p → q) | (p → ¬q) | (p → q) ∨ (p → ¬q) |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 |

**Q5.** Use the truth tables method to determine whether p → (q∧ ¬q) equivalent.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| p | q | (q∧ ¬q) | p → (q∧ ¬q) | ¬p |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 |

**Q6.** Let’s consider a propositional language where

* + p means “Paola is happy”,
  + q means “Paola paints a picture”,
  + r means “Renzo is happy”.

Formalize the following sentences:

1. “if Paola is happy and paints a picture then Renzo isn’t happy”

(p ∧q) →¬r

1. “if Paola is happy, then she paints a picture”

p →q

1. “Paola is happy only if she paints a picture”

p → q

¬p are logically

**Q7.** Let’s consider a propositional language where

* p means “x is a prime number”,
* q means “x is odd”.

Formalize the following sentences:

1. “x being prime is a sufficient condition for x being odd”

p →q

1. “x being odd is a necessary condition for x being prime”

q →p

**Q8.** Let A =“Aldo is Italian” and B =“Bob is English”. Formalize the following sentences:

* 1. “Aldo isn’t Italian”

¬A

* 1. “Aldo is Italian while Bob is English”

A∧B

* 1. “If Aldo is Italian then Bob is not English”

A→¬B

* 1. “Aldo is Italian or if Aldo isn’t Italian then Bob is English”

A∨(¬A →B)

* 1. “Either Aldo is Italian and Bob is English, or neither Aldo is Italian nor Bob is English”

(A∧B) ∨(¬A∧¬B)

**Q9.** Assume that the following sentences are in our Knowledge Base (A denotes the negation of A):

A

A  B  C

B  D  E

C  D  E  F

Using the inference rules that we studied in class for propositional logic, prove that “F is true”. When you derive F, specify exactly the sequence of inference rules that you used.

A 1

A => B and C 2

B => D and E 3

C => D or E or F 4

5. A=0 [1]

6. B  C=1 [1,2]

7. B=0, C=0 [6]

8. D  E=1 [3,6]

9. D=0, E=0 [8]

10.C  F [4,8]

11. F is true

**Q10.** Let’s consider a propositional language where ∨ ∧ → 

* A =“Angelo comes to the party”,
* B =“Bruno comes to the party”,
* C =“Carlo comes to the party”,
* D =“Davide comes to the party”.

Formalize the following sentences:

1. “If Davide comes to the party then Bruno and Carlo come too”

D→(B∧C)

1. “Carlo comes to the party only if Angelo and Bruno do not come”

C→ (A∨B)

1. “Davide comes to the party if and only if Carlo comes and Angelo doesn’t come”

D↔(C∧A)

1. “If Davide comes to the party, then, if Carlo doesn’t come then Angelo comes”

D→(C→A)

1. “Carlo comes to the party provided that Davide doesn’t come, but, if Davide comes, then Bruno doesn’t come”

(D→C) ∧(D→B)

1. “A necessary condition for Angelo coming to the party, is that, if Bruno and Carlo aren’t coming, Davide comes”

(B∧C→D) → A

1. “Angelo, Bruno and Carlo come to the party if and only if Davide doesn’t come, but, if neither Angelo nor Bruno come, then Davide comes only if Carlo comes”

((A∧B∧C) ↔D) ∧((A∧B) →( D →C))

**Q11**

Socrate says:

“If I’m guilty, I must be punished; I’m guilty. Thus I must be punished.”

*Is the argument logically correct?*

**Q1*2*.** Consider a propositional language with three propositional constants - snake (s), colorful (c), and poisonous (p). Using these propositional constants, encode the following English sentences as Propositional Logic sentences (e.g. “All colorful snakes are

poisonous” is encoded by s ∧ c → p)

1. A snake is poisonous only if it is colorful.

(s ∧p) → c

1. A snake is not poisonous unless it is colorful.

c → (s ∧p)

1. No colorful snake is poisonous.

 s ∧ c ∧ p

**Q1*3*.** Prove the following logical equivalence

# ¬q  [(¬(p ¬p)  r]  s  s  q

# ¬q  [(¬(p ¬p)  r] s

# ¬q  [F  r] s

# ¬q  s

# p s

#  s  q

**Q14.** Express the following sentences using unary predicates and propositional connectives.

* 1. John is a tall child.
  2. x is short or tall.
  3. John is not a clever.
  4. Peter is not a clever child.
  5. A country is a good holiday resort if it is sunny and dry