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# Artificial Intelligence
## Final Test

### Problem 1

Given the following formulas in propositional logic:

→ $\varphi_1 : (p \rightarrow q)$

→ $\varphi_2 : (q \rightarrow (s \wedge t))$

→ $\varphi_3 : (r \rightarrow (s \wedge t))$

→ $\varphi_4 : (p \vee r)$

### Solution:-

By using the resolution to device empty clause from CNF (conjunctive normal form) of $(\cancel{\varphi_1} \varphi_1 \wedge \varphi_2 \wedge \varphi_3 \wedge \varphi_4) \wedge \neg \Phi$

where as $\varphi_1 = (p \rightarrow q) \equiv (\neg q \vee q)$ which are logically equivalents.

$$\varphi \rightarrow \psi = \neg \varphi \vee \psi$$

$$\varphi_2 : (q \rightarrow (s \wedge t)) \equiv \neg q \vee (s \wedge t)$$
$$\equiv (\neg q \vee s) \wedge (\neg q \wedge t).$$

$$\varphi_3 : (r \rightarrow (s \wedge t)) \equiv \neg r \vee (s \wedge t)$$
$$= (\neg r \vee s) \wedge (\neg r \vee t).$$

$$\varphi_4 : (p \vee r)$$

where as the clauses for ~~$\varphi_1 \wedge \varphi_2 \wedge \varphi_3 \wedge \varphi_4$~~ $\varphi_1, \varphi_2, \varphi_3, \varphi_4$

$\varphi_1$:
1. $\{\neg p\}$
2. $\{q\}$

$\varphi_2$:
3. $\neg q$
4. $s$
5. $\neg q$
6. $t$

$\varphi_3$:
7. $\neg r$
8. $s$
9. $\neg r$
10. $t$

$\varphi_4$:
11. $p$
12. $r$

$\varphi_1, \varphi_2, \varphi_3, \varphi_4$ are logically consistant because ~~of to~~ they are no to. There every formulae $\varphi$ is s logical consicewence of them.

To satesfy $\varphi_1, \varphi_2, \varphi_3, \varphi_4$ we must chose interpretation;

S.t $P^i = T$ $Q^i = F$ $r^i = T$

To show whether $\varphi$ is $\equiv s \wedge t$ is a logical conseqvence of $\varphi_1 \wedge \varphi_2 \wedge \varphi_3 \wedge \varphi_4$ we ~~ha~~ should consider the classes.

$$\neg\varphi \equiv \neg(s \wedge t) \equiv \neg s \vee \neg t \quad \left.\begin{matrix} \neg s \\ 14.\ \neg t \end{matrix}\right\}$$

The empth clasise can be devided from classes 1 and 2 from 4 & 5 or 8 & 9.

$\therefore \Phi$ is logical consequence.

Problem:-5

1) $\forall_x . likes(x,x)$
2) $\forall x . \exists y . likes(x,y)$
3) $\exists y . \forall x . likes(x,y)$
4) $\forall x . \forall y . likes(x,y) \rightarrow likes(y,x)$
5) $\forall x . \forall y . (\exists z . likes(x,z) \land likes(z,y)) \longrightarrow likes(x,y)$

| | Abby | Bess | Cody | Dana |
|---|---|---|---|---|
| Abby | x | – | x | x |
| Bess | – | x | – | x |
| Cody | – | – | x | – |
| Dana | – | x | x | – |

Solution:-

likes (Abby, Abby)
~ likes (Abby, Bess)
likes (Abby, Cody)
likes (Abby, Dana)

~ likes (Bess, Abby)
likes (Bess, Bess)
~ likes (Bess, Cody)
likes (Bess, Dana)

~ likes (Cody, Abby)
~ likes (Cody, Bess)
likes (Cody, Cody)
~ likes (Cody, Dana)

~ likes (Dana, Abby)
likes (Dana, Bess)
likes (Dana, Cody)
~ likes (Dana, Dana)

1.) $\forall x$ likes$(x, x)$

$\therefore \forall x \Rightarrow$ Universal

$x$ = Abby, Bess, Cody, Dana

Likes (Abby, Abby) True

Likes (Bess, Bess) True

Likes (Cody, Cody) True

Likes (Dana, Dana) False

$\therefore$ $\forall x$ likes$(x, x)$ is false

2) $\forall x\, \exists y.$ likes$(x, y)$ it means everyonebody likes somebody

$\exists y \Rightarrow$ Existential

$\exists y$ likes(Abby, $y$). likes (Abby, Cody)

$\exists y$ likes(Bess, $y$). likes (Bass, Bess)

$\exists y$ likes (Cody, $y$) likes (Cody, Cody)

$\exists y$ likes(Dana, $y$) likes (Dany, Cody).

$\forall x\, \exists y$ likes $(x, y)$ is true

3) $\exists y.\, \forall x$ likes$(x, y)$

Directly we cen declare it false because Dana dosent likes herself

$\exists y$ likes (Abby, Abby) True

$\exists y$ likes (Bess, Bess) True

$\exists y$ likes (Cody, Cody) True

$\exists y$ likes (Dana, Dana) False

4) $\forall x \ \forall y$ likes $(x, y \rightarrow$ lieks$(y, x)$.

$\forall x \ \forall y$ as univeser so we must chack for every for instance

likes(obby cody) True. But likes (cody, Abby) false

Hence $\forall x \ \forall y$ likes$(x, y) \rightarrow$ likes$(y, x)$ is false.

5.) $\forall x \ \forall y \ (\exists z \cdot$ likes$(x, z) \wedge$ likes$(x, y)) \rightarrow$ likes $(x, y)$.

likes (Abby, Dana).

likes (Dana, Bess).

$\neg$ likes (Abby, Bess).

$\therefore \ \forall x \ \forall y \ (\exists z \cdot$ likes$(x, z) \wedge$ likes$(z, y)) \rightarrow$ likes $(x, y)$.