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Department of Computing
Academic Year **2020-2021**
Page created Tue Nov 3 23:15:08 GMT 2020

70051 rac101 2 t5 ys1220 v1 001200015010	Electronic submission **Mon - 02 Nov 2020** **00:47:03** ys1220

Exercise Information

Module:	70051 Introduction to Symbolic Artificial Intelligence (MSc AI)	**Issued:**	Tue - 20 Oct 2020
Exercise:	2 (CW)	**Due:**	Tue - 03 Nov 2020
Title:	Logic	**Assessment:**	Individual
FAO:	Craven, Robert (rac101)	**Submission:**	Electronic

Student Declaration - Version 1

- I declare that this final submitted version is my unaided work.

Signed: (electronic signature) Date: 2020-11-02 00:41:23

For Markers only: (circle appropriate grade)

SUN, Yipengjing (ys1220)	01905476	t5	2020-11-02 00:41:23	**A* A B C D E F**

1.

i) p: Michel is fulfilled, q: Michel is rich
r: Michel will live another five years

$((\neg(p \vee q)) \rightarrow (\neg r))$

ii) p: the snowdorm arrives, q: Raheem will wear his boots.
r: I'm sure the snowstorm will arrive.

$((p \vee q) \wedge r)$

iii) p: Akira is on set, q: Toshiro is on set
r: the film will begin, h: caterers have cleared out

$((p \wedge q) \rightarrow (r \leftrightarrow h))$

iv) p: Iraq arrived, q: Sarah arrived

$((p \vee (\neg q)) \wedge (\neg(p \wedge (\neg q))))$

v) p: Herbert heard the performance
q: Anne-Sophie heard the performance
r: Anne-Sophie answered the phone calls

$((\neg r) \rightarrow (\neg(p \wedge q)))$

2. i) A propositional formula A is satisfiable if there is some v such that $h_v(A) = t$

ii) A, B are logically equivalent if for every v, $h_v(A) = h_v(B)$

iii) Suppose $(\neg A)$ is satisfiable, then $h_v(\neg A) = t$ for for some v
If $h_v(A) = f$, then $h_v(\neg\neg A) = f$, but $h_v(T) = t$
So $\neg\neg A \not\equiv T$
On the other hand, if $\neg\neg A \not\equiv T$, which means $h_v(\neg\neg A) = f$ for some v. It implies $h_v(\neg A) = t$ for some v. Therefore, $(\neg A)$ is satisfiable

3.

p	q	r	$(p \wedge \neg q \leftrightarrow \neg(\neg r \vee \neg p)) \to (\neg\neg q \to r)$
t	t	t	$t\ \underline{f}\ f\ \boxed{f}\ \underline{t}\ f\ f\ f\quad t\quad t\ \boxed{t}\ t$
t	t	f	$t\ \underline{f}\ f\ \boxed{t}\ \underline{f}\ t\ t\ f\quad f\quad t\ \boxed{f}\ f$
t	f	t	
t	f	f	
f	t	t	
f	t	f	
f	f	t	

$f \quad f \quad f \quad ||$

It's not valid, since the function h_v not always equals to t for any v.

4. i)

CNF: a、b、g, h

DNF: b、e、g, h

ii)

Let S be in CNF. S is satisfiable iff $S \nvdash_{\text{res(p.s)}} \emptyset$

It's important since it's the heart of many SAT-solvers

iii) a. $\{\{p, s\}, \{q, r\}, \{\neg s, q\}, \{\neg p, \neg r, \neg s\}\}$

$\Rightarrow$ q is pure, apply pure rule

$\{\{p, s\}, \{\neg p, \neg r, \neg s\}\}$

$\Rightarrow$ $\neg r$ is pure, apply pure rule

$\{\{p, s\}\}$

b. $\{\{\neg p, q, r\}, \{\neg q\}, \{p, r, q\}, \{\neg r, q\}\}$

[illegible]

$\Rightarrow$ $\neg q$ is a unit clause, apply unit propogation

$\{\{\neg p, r\}, \{p, r\}, \{\neg r\}\}$

$\Rightarrow$ $\neg r$ is a unit clause, apply unit propogation

$\{\{\neg p\}, \{p\}\}$

$\Rightarrow$ p is a unit clause, apply unit propogation

$\{\{\}\}$

5、 p: I'm going, q: you're going, r: Tara is going

$p \rightarrow \neg q$, $\neg q \rightarrow \neg r$, $r \vee \neg p$, $r \vee p$

$\Downarrow$ $\Downarrow$

$(\neg p \vee \neg q)$ $(q \vee \neg r)$

$S = \{\{\neg p, \neg q\}, \{q, \neg r\}, \{r, \neg p\}, \{r, p\}\}$

$\Rightarrow$ resolvent $\{r, \neg p\}, \{r, p\}$ on p

$\{\{\neg p, \neg q\}, \{q, \neg r\}, \{r\}\}$

$\Rightarrow$ $(\neg p)$ is pure

$\{\{q, \neg r\}, \{r\}\}$

$\Rightarrow$ resolvent $\{q, \neg r\}, \{r\}$ on $\{r\}$

$\{\{q\}\}$

Since $S \vdash_{resip(L)} \{q\}$, $S \models q$

therefore, it's valid

6、

i) $C = \{Andrea\}$ $P_1 = \{cupcake\}$

$P_2 = \{aunts\}$ $P_3 = \{gave\}$

$F_1 = \{aunts\}$

$\forall X \exists Y \exists Z (aunts(X, aunts(Andrea)) \wedge cupcake(Y) \wedge gave(X, Y, Z) \wedge \neg gave(X, Y, Andrea))$

ii) $P_1 = \{computer\}$

$P_2 = \{connected\}$

$\exists X \forall Y (computer(X) \wedge computer(Y) \wedge connected(X, Y) \wedge \neg connected(X, X))$

iii) $C = \{Paul\ Klee, Kandinsky\}$

$P_1 = \{British\ Gallery, room\}$

$P_2 = \{hangs, painting, in\}$

$\forall X \exists Y \exists Z \forall M ($ painting$(X, paulklee) \land$ BritishGallery$(Y) \land$ room(Z)
$\land\, in(Z, Y) \land hangs(X, Z) \land painting(M, kandinsky)$
$\land\, hangs(M, Z))$

iv) $P_2 = \{love\}$

$\exists X \forall Y (\neg love(X, Y) \rightarrow \neg love(Y, X))$

7.

i) $\forall X (a(k, X) \rightarrow \neg(X = j))$

it will be true for any X such that $a(k, X)$ is false, since $a(k, l)$ is false, so $a(k, X)$ is false $\Rightarrow$ It is true

ii) $c(l) \rightarrow \exists X (b(X) \land c(X) \land a(l, X))$

it will be true if $c(l)$ is false or
$\exists X(b(X) \land c(X) \land a(l, X))$ is true
since l is drawn circular, $c(l)$ is true.
Both j and k satisfy filled and circular and have a directed arrow from l, so $\exists X(b(X) \land c(X) \land a(l, X))$

is true

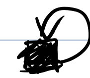
Therefore, it is true.

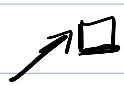
iii) $\exists X \neg \exists Y (\neg (X = Y) \wedge a(X, Y))$

There exists X but does not exist Y such that $X \neq Y$, which means that there exists X such that for all Y, $X = Y$. Cannot find such X. So it is false

iv) $\forall X (\neg s(X) \rightarrow \exists Y (c(Y) \wedge b(Y) \wedge a(X, Y)))$

For all X, X is not square objects.

it is false, since there are  and



Therefore, it is true.

v) $\forall X (\exists Y (\neg (X = Y) \wedge a(X, Y)) \rightarrow \exists Y (a(X, Y) \wedge a(Y, X)))$

It will be true if $\exists Y (\neg (X = Y) \wedge a(X, Y))$ is false or

$\exists Y (a(X, Y) \wedge a(Y, X))$ is true

For all X, such that there is Y, $X \neq Y$
and there is a directed arrow from X to Y
It is false since X contains Y, so there
~~must~~ be one $X = Y$
Therefore it's true.

v i) $\forall X \forall Y (a(X,j) \wedge a(Y,j) \rightarrow (a(X,Y) \vee a(Y,X)))$

It's true since there are objects
that have no arrow to j
So $a(X,j) \wedge a(Y,j)$ is false,
then the whole formula is true.