CS 271 - Introduction to Artificial Intelligence **Fall 2016**

HomeWork 5

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Problem 1 **Solution:**

Define cost function as how many constrains are violated. At beginning the cost is 4.

(a) answer is 1. Only B = True, A = True.

(b) answer is 15. A = False or B = False or C = False or D = False;

(c) answer is 0.

Problem 2 **Solution:**

Set: Locate(a,b): a is at b' house.

Statement: ¬locate(car,Fred) → locate(a,John)

Constrains: No, I can not.

Problem 3 **Solution:**

First, it is obvious that a must be true, otherwise for any logical expression s $s \land \neg a = Flase$ i.e. it is unsatisfied.

a	P	Q	$P \lor a$	$Q \lor \neg a$
1	0	0	1	0
1	0	1	1	1
1	1	0	1	0
1	1	1	1	1

From the table, we can conclude, for any logical expression P, Q, $P \lor a = 1, Q \lor \neg a = Q$. Thus the unit resolution is sound.

Problem 4 **Solution:**

$$\neg[((P \lor \neg Q) \to R) \to (P \land Q)]$$
$$\neg[(\neg(P \lor \neg Q) \lor R) \to (P \land Q)]$$
$$\neg[\neg(\neg(P \lor \neg Q) \lor R) \lor (P \land Q)]$$
$$(\neg P \lor R) \land (Q \lor R) \land (\neg P \lor \neg Q)$$

Problem 5 **Solution:**

$r_{i,j} = \neg q_{i,1} \land \neg q_{i,2} \land ... \land \neg q_{i,j-1} \land q_{i,j} \land \neg q_{i,j+1} \land ... \land \neg q_{i,n}$
$R_i = r_{i,1} \lor r_{i,2} \lor ... \lor r_{i,n}$

$Row = R_0 \wedge R_1 \wedge ... \wedge R_n$

$c_{i,j} = \neg q_{1,j} \wedge \neg q_{2,j} \wedge ... \wedge \neg q_{i-1,j} \wedge q_{i,j} \wedge \neg q_{i+1,j} \wedge ... \wedge \neg q_{n,j}$
$C_i = c_{1,i} \vee c_{2,i} \vee ... \vee c_{n,i}$
$Col = C_1 \wedge C_2 \wedge ... \wedge C_n$

$xd^1_{i,j} = \neg q_{1,j-i+1} \wedge \neg q_{2,j} \wedge ... \wedge \neg q_{i-1,j-1} \wedge q_{i,j} \wedge \neg q_{i+1,j+1} \wedge ... \wedge \neg q_{n,i-j+m}(i \leq j)$
$xd^1_{i,j} = \neg q_{i-j+1,1} \wedge \neg q_{2,j} \wedge ... \wedge \neg q_{i-1,j-1} \wedge q_{i,j} \wedge \neg q_{i+1,j+1} \wedge ... \wedge \neg q_{n,j-i+n}(i > j)$
$xD_i = \bigvee_{x-y=i} xd_{x,y}$
$xDiagnol = xD_{-m} \wedge xD_{-m+1} \wedge ... \wedge xD_n$

$yd_{i,j} = \neg q_{1,i+j-1} \wedge \neg q_{2,i+j-2} \wedge ... \wedge \neg q_{i-1,j+1} \wedge q_{i,j} \wedge \neg q_{i+1,j-1} \wedge ... \wedge \neg q_{i+j-1,1}(i \leq j)$
$yd_{i,j} = \neg q_{i+j-m,m} \wedge \neg q_{i+j-m+1,m-1} \wedge ... \wedge \neg q_{i-1,j+1} \wedge q_{i,j} \wedge \neg q_{i+1,j-1} \wedge ... \wedge \neg q_{n,m-i-j}(i > j)$
$yD_i = \bigvee_{x+y=i} d_{x,y}$
$yDiagnol = D_2 \wedge D_3 \wedge ... \wedge D_{n+m}$

Final answer is $Row \wedge COl \wedge xDiagnol \wedge yDiagnol$.

Problem 6 **Solution:**

(a) Table is shown below:

P	Q	R	$P \wedge (Q \wedge R)$	$(P \wedge Q) \wedge R$
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

(b) Table is shown below:

P	Q	R	$P \wedge (Q \vee R)$	$(P \wedge Q) \vee (P \wedge R)$
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

(c) Table is shown below:

P	Q	$\neg(P \wedge Q)$	$\neg P \vee \neg Q$
0	0	1	1
0	1	1	1
1	0	1	1
1	1	0	0

(d) Table is shown below:

P	Q	$P \leftrightarrow Q$	$(P \wedge Q) \vee (\neg P \wedge \neg Q)$
0	0	1	1
0	1	0	0
1	0	0	0
1	1	1	1

Problem 7 **Solution:**

(a) valid, $\neg Smoke \vee Smoke$.

(b) Neither

(c) Neither $\neg(\neg Smoke \vee Fire) \vee (Smoke \vee \neg Fire)$
$(\ Smoke \wedge \neg Fire) \vee Smoke \vee \neg Fire$
$Smoke \vee \neg Fire$

(d) valid, $Smoke \vee Fire \vee \neg Fire = Smoke \vee True = True$

(e) valid, $\neg Smoke \vee \neg Heat \vee Fire \leftrightarrow \neg Smoke \vee \neg Heat \vee Fire$. Left part and right part are same.

(f) valid $Big \vee Dumb \vee \neg Dumb \vee Big = True \vee Big = True$.

Problem 8 **Solution:**

$\{\neg P \vee Q, \neg L \vee \neg M \vee P, \neg B \vee \neg L \vee M, \neg A \vee \neg P \vee L, \neg A \vee B \vee L, A, B\}$