

Quiz 3

Task 1

(a)

In the table, for all the scenarios where k_B is true, S_1 is also true.

$$\text{So } k_B \models S_1$$

(b)

There is at least one scenario where $(\text{not } k_B) \rightarrow$ true (k_B is false) where $(\text{not } S_1) \rightarrow$ false (S_1 is true).

$$\text{So } (\text{not } k_B) \not\models (\text{not } S_1)$$

Task 2

Consider a statement that meets the required scenario

$$\neg \left[(A \wedge \neg B \wedge C \wedge \neg D) \vee (\neg A \wedge \neg B \wedge C \wedge D) \right]$$

Converting to CNF

Apply DeMorgan's

$$\neg(A \wedge \neg B \wedge C \wedge \neg D) \wedge \neg(\neg A \wedge \neg B \wedge C \wedge D)$$

$$[\neg A \vee \neg(\neg B) \wedge \neg C \wedge \neg(\neg D)] \wedge [\neg(\neg A) \vee \neg(\neg B) \vee \neg C \vee \neg D]$$

Apply Double negation

$$[\neg A \vee B \vee \neg C \vee D] \wedge [A \vee B \vee \neg C \vee \neg D]$$

Task 3

(i) Convert KB to Horn Form

$$A \Rightarrow C$$

$$B \Rightarrow C$$

$$C \Rightarrow B$$

$$D \Rightarrow A$$

E

$$(B \wedge E) \Rightarrow a$$

$$B \Rightarrow F$$

D

Applying MP,

$$\frac{D \Rightarrow A \quad D}{A}$$

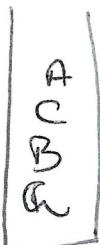
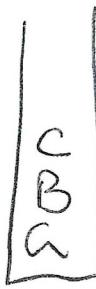
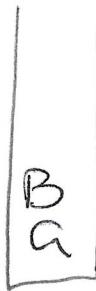
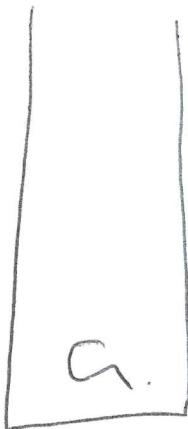
$$\frac{(B \wedge E) \Rightarrow a \quad B, E}{a}$$

$$\frac{A \Rightarrow C \quad A}{C}$$

$$\frac{C \Rightarrow B \quad C}{B}$$

So $\text{KB} \models a$

(ii) Goal Stack



MP Applications,



$$\frac{D \Rightarrow A \quad D}{A}$$

X
B
C

$$\frac{A \Rightarrow C \quad A}{C}$$

B
C

$$\frac{C \Rightarrow B \quad C}{B}$$

X

$$\frac{(B \wedge E) \Rightarrow a \quad B, E}{G \parallel}$$

so $\text{KB} \models a$

(iii) Convert to CNF,

Remove \Leftarrow

$$(A \Rightarrow C) \wedge (B \Rightarrow C) \wedge (C \Rightarrow B) \wedge (D \Rightarrow A) \wedge E \\ \wedge [(CB \wedge E) \Rightarrow a] \wedge (B \Rightarrow F) \wedge D$$

Remove \Rightarrow

$$(\neg A \vee C) \wedge (\neg B \vee C) \wedge (\neg C \vee B) \wedge (\neg D \vee A) \wedge E \\ \wedge (\neg (CB \wedge E) \vee a) \wedge (\neg B \vee F) \wedge D$$

Move \neg Inward

$$(\neg A \vee C) \wedge (\neg B \vee C) \wedge (\neg C \vee B) \wedge \\ (\neg D \vee A) \wedge E \wedge (\neg B \vee \neg E \vee A) \\ \wedge (\neg B \vee F) \wedge D$$

Which is in CNF

Take CNF of $\neg \alpha$: $\neg G$

Proof of Resolution,

$$\frac{\neg G \quad \neg B \vee \neg E \vee A}{\neg B \vee \neg E}$$

$$\frac{\neg B \vee E \quad E}{\neg B}$$

$$\frac{\neg C \quad \neg A \vee C}{\neg A}$$

$$\frac{\neg B \quad \neg C \vee B}{\neg C}$$

$$\frac{\neg A \quad \neg D \vee A}{\neg D}$$

$$\frac{\neg D \quad D}{\text{empty}} \rightarrow KBFQ$$

TASK 4

CONSTANTS: MON, JOHN, MARY

PREDICATES: RAIN(X): It rains on X

GAVE LOOT(X,Y): X gave Y a check
on Tuesday

MOW(X): X mowed lawn on
Wednesday

(a)

$\text{RAIN}(\text{MON}) \Rightarrow \text{GAVE LOOT}(\text{JOHN}, \text{MARY})$

$\text{GAVE LOOT}(\text{JOHN}, \text{MARY}) \Rightarrow \text{MOW}(\text{MARY})$

(b)

$\neg \text{RAIN}(\text{MON}) \wedge \text{GAVE LOOT}(\text{JOHN}, \text{MARY}) \wedge \text{MOW}(\text{MARY})$

(c) You need 15 symbols

$S_1 : \text{RAIN}(\text{MON})$

$S_2 : \text{RAIN}(\text{JOHN})$

$S_3 : \text{RAIN}(\text{MARY})$

S₄: GAVE LOOT (Mon, Mon)

S₅: GAVE LOOT (Mon, John)

S₆: GAVE LOOT (Mon, Mary)

S₇: GAVE LOOT (John, Mon)

S₈: GAVE LOOT (John, John)

S₉: GAVE LOOT (John, Mary)

S₁₀: GAVE LOOT (Mary, Mon)

S₁₁: GAVE LOOT (Mary, John)

S₁₂: GAVE LOOT (Moses, Moses)

S₁₃: Mow (Mon)

S₁₄: Mow (John)

S₁₅: Mow (Mary)

Part (a) :

$$S_1 \Rightarrow S_9$$

$$S_9 \Rightarrow S_{15}$$

Part (b) : $S_1 \wedge S_9 \wedge S_{15}$

(d)

In every scenario where events are true ($S_1 = F, S_9 = T, S_{15} = T$) we can see that the contract is True

So Events F Contract.

So Contract is not violated.

Task 5

- (i) $\{x/Bb, y/Tm\}$
- (ii) $\{y/Bb, x/Bb\}$
- (iii) None exists.
- (iv) $\{x/y, z/Bb\}$.
- (v) None exists.

TASK 6

PREDICATES

$\text{IsAdj}(x, y)$: True if x is Adjacent to y .

$\text{In}(x, y)$: True if x is in y

$\text{IsBlank}(x)$: True if x is Blank

CONSTANTS

$L_1, L_2, L_3, L_4, L_5, L_6, L_7, L_8, L_9, 1, 2, 3,$
 $4, 5, 6, 7, 8$

INITIAL STATE

$$\begin{aligned} & \text{In}(2, L_1) \wedge \text{In}(3, L_2) \wedge \text{In}(6, L_3) \wedge \text{In}(1, L_4) \\ & \wedge \text{IsBlank}(L_5) \wedge \text{In}(7, L_6) \wedge \text{In}(4, L_7) \wedge \text{In}(8, L_8) \\ & \wedge \text{In}(5, L_9) \wedge \text{IsAdj}(L_1, L_2) \wedge \text{IsAdj}(L_2, L_1) \wedge \text{IsAdj}(L_1, L_4) \\ & \wedge \text{IsAdj}(L_2, L_3) \wedge \text{IsAdj}(L_2, L_5) \wedge \text{IsAdj}(L_3, L_2) \wedge \text{IsAdj}(L_3, L_6) \\ & \wedge \text{IsAdj}(L_4, L_1) \wedge \text{IsAdj}(L_4, L_5) \wedge \text{IsAdj}(L_4, L_7) \wedge \text{IsAdj}(L_5, L_2) \\ & \wedge \text{IsAdj}(L_5, L_4) \wedge \text{IsAdj}(L_5, L_6) \wedge \text{IsAdj}(L_5, L_8) \wedge \text{IsAdj}(L_6, L_3) \\ & \wedge \text{IsAdj}(L_6, L_5) \wedge \text{IsAdj}(L_6, L_9) \wedge \text{IsAdj}(L_7, L_4) \wedge \text{IsAdj}(L_7, L_8) \end{aligned}$$

$\wedge \text{IsAdj}(L8, L7) \wedge \text{IsAdj}(L8, L5) \wedge \text{IsAdj}(L8, L9)$
 $\wedge \text{IsAdj}(L9, L6) \wedge \text{IsAdj}(L9, L8)$

GOAL TEST

If State Entails

$\text{In}(1, L1) \wedge \text{In}(2, L2) \wedge \text{In}(3, L3) \wedge \text{In}(4, L4)$
 $\wedge \text{In}(5, L5) \wedge \text{In}(6, L6) \wedge \text{In}(7, L7) \wedge \text{In}(8, L8)$

Actions

SWAP(tile, src, dest)

PRE
 $\text{In}(\text{tile}, \text{src}) \wedge \text{IsBlank}(\text{dest}) \wedge \text{IsAdj}(\text{src}, \text{dest})$

EFT
 $\text{In}(\text{tile}, \text{dest}) \wedge \text{IsBlank}(\text{src}) \wedge \neg \text{IsBlank}(\text{dest})$
 $\wedge \neg \text{In}(\text{tile}, \text{src})$

Task 7

Number of arguments per predicate : $[1 \quad 4]$

Number of constants : 5

Possible assignments to each predicate $[5^1 \quad 5^4]$
 $[5 \quad 625]$

Total number of possible assignments (atomic sentences)

$$\left[3 \times 5^1 \quad 3 \times 5^4 \right]$$

$$\left[15 \quad 1875 \right]$$

Since PDDL KBs [state descriptions] are defined by which of the sentences are true,

Num of possible states $\left[2^{15} \quad 2^{1875} \right]$