Topic 2.2 Limitations of Logical Inference: An example

A goal based logical agent for simplified 'Treasure Hunt: A Risky Business'
[Find Gold avoiding Monsters]

a) Problem

1,4			
1,3			
1,2			
1,1	2,1	3,1	4,1

Environment: 4x4 grid; Probability of a monster at a cell except [1,1] is > 0, and independent; Gold is hidden in some cells.

b) Assumptions

$A_{i,j}$ – the agent is in [i,j]
$\neg M_{i,j}$ – no monster is in [i,j]
$G_{i,j}$ – gold glitters in [i,j]
$S_{i,j}$ – smell of a monster is perceived in [i,j]

Actions: MoveToRight, MoveUp, ShoutWow, CryAhh, …

Example of a percept: $S_{i,j} \wedge \neg M_{i,j} \wedge \neg G_{i,j}$

c) Initial KB

1. $S_{i,j} \Leftrightarrow M_{i-1,j} \vee M_{i+1,j} \vee M_{i,j-1} \vee M_{i,j+1}$
2. $(i \geq 1) \wedge (j \geq 1) \wedge (i \leq 4) \wedge (j \leq 4)$
3. $\neg M_{1,1} \wedge \neg S_{1,1} \wedge \neg G_{1,1}$
4. $A_{1,1}$

1,2	
$\neg M$ $\neg G$ $\neg S$ 1,1 A	2,1

d) Reasoning

T1. $\neg S_{1,1}$ [Similarly, $\neg M_{1,1}$, $\neg G_{1,1}$]   [Simplification; 3]

T2. $S_{1,1} \Leftrightarrow M_{2,1} \vee M_{1,2}$ [1, 2, T1]

T3. $(S_{1,1} \Rightarrow M_{2,1} \vee M_{1,2}) \wedge (M_{2,1} \vee M_{1,2} \Rightarrow S_{1,1})$ [Elimination of $\Leftrightarrow$]

T4. $M_{2,1} \vee M_{1,2} \Rightarrow S_{1,1}$ [Simplification; T3]

T5. $\neg S_{1,1} \Rightarrow \neg(M_{2,1} \vee M_{1,2})$ [Contrapositive; T4]

T6. $\neg(M_{2,1} \vee M_{1,2})$ [Modus ponens; T1, T5]

T7. $\neg M_{2,1} \wedge \neg M_{1,2}$ [DeMorgan's Law; T6]

So, we get $\neg M_{2,1}$ and $\neg M_{1,2}$ by Simplification of T7.

Useful addition to KB after reasoning:

5. $\neg M_{2,1}$ **6.** $\neg M_{1,2}$

$\neg M$ 1,2	
$\neg M$ $\neg G$ $\neg S$ 1,1 A	$\neg M$ 2,1

Decision: **Safe to move to right or up**

Action taken, say: **MoveToRight**

Important Changes:

4. A̶₁̶,̶₁̶ ; $A_{2,1}$

New percept, suppose: $S_{2,1} \wedge \neg M_{2,1} \wedge \neg G_{2,1}$

$\neg M$ 1,2	
$\neg M$ $\neg G$ $\neg S$ 1,1	$\neg M$ $\neg G$ S 2,1 A

Result of further reasoning [Self study]:
$S_{2,1}$
$\mathbf{M_{2,2} \vee M_{3,1}}$

Actions taken, say: MoveToLeft, MoveUp

New percept, suppose: $S_{1,2} \wedge \neg M_{1,2} \wedge \neg G_{1,2}$

$\neg M \;\; \neg G \qquad S$ 1,2 $\qquad\qquad$ A	
$\neg M \;\; \neg G \;\; \neg S$ 1,1	$\neg M \;\; \neg G \qquad S$ 2,1

Result of further reasoning:

$S_{1,2}$

$M_{2,\,2} \vee M_{1,\,3}$

So, $M_{1,\,3}$ or $M_{2,\,2}$ or $M_{3,\,1}$ may hold, but the combination is uncertain!!!

$?M$ 1,3		
$\neg M \;\; \neg G \qquad S$ 1,2 $\qquad\qquad$ A	$?M$ 2,2	
$\neg M \;\; \neg G \;\; \neg S$ 1,1	$\neg M \;\; \neg G \qquad S$ 2,1	$?M$ 3,1

What to do next?