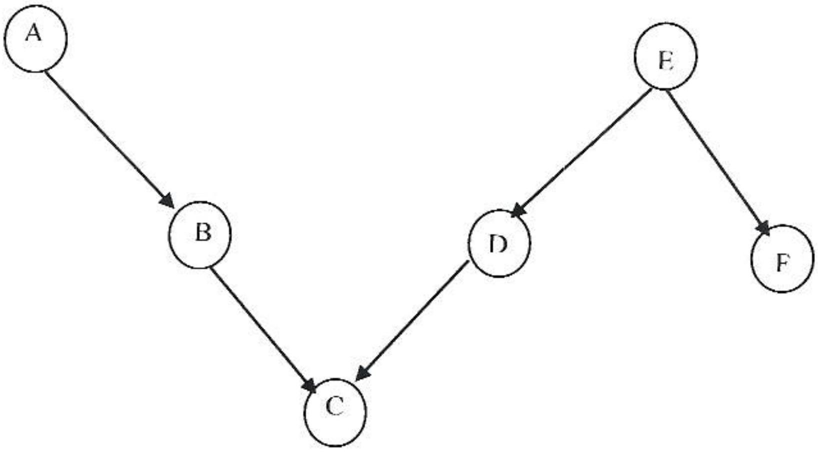
שאלה 4 (25 נק')

נתונה הרשת הבייסיאנית הבאה :



B	D	P(C|B,D)
t	*t*	0.8
t	*f*	0.6
f	*t*	0.4
f	*f*	0.2

P(A)
0.7

P(E)
0.4

A	P(B|A)
t	0.3
f	0.5

E	P(D|E)
t	0.8
f	0.2

E	P(F|E)
t	0.1
f	0.7

חשבו :

P(B,D), P(B,D|C), P(A|C), P(C,F|D), P(F|¬A,C)

$$p(B\cap D) = [p(B|A)\,p(A) + p(B|\neg A)\,p(\neg A)]\,[p(D|E)\,p(E) + p(D|\neg E)\cdot p(\neg E)]$$

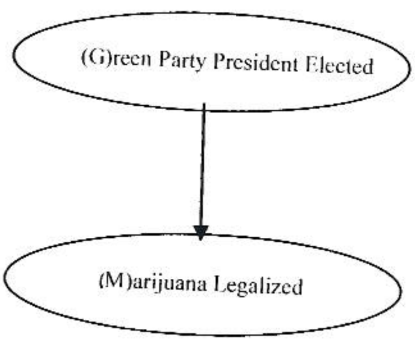
$$p(B\cap D|C) = \frac{p(C|B\cap D)\cdot p(B\cap D)}{p(C)}$$

שאלה 3 (30 נק')

כעת תקופת הבחירות העירוניות ויתכן שבעיר סדום יבחר מועמד מפלגת הירוקים. פלוני מאמין שיש סיכוי גבוה יותר שנשיא ממפלגת הירוקים יהפוך את המריחואנה לחוקית לעומת מועמדים ממפלגות אחרות, אבל גם כל נבחר אחר יכול להפוך את המריחואנה לחוקית.

נתאר את המצב בעזרת הרשת הביסיאנית שלהלן :

P(G)
0.1



G	P(M)
t	0.667
f	0.25

א. אמצעי התקשורת הודיעו שהמריחואנה עומדת להיות חוקית אך לא ידוע עדיין מי זכה בבחירות.
מהי ההסתברות P(G|M) לכך שנבחר נשיא ממפלגת הירוקים?

ב. אם יהיה לנו יותר מידע, נוכל לבצע היסקים טובים יותר. נרחיב את הרשת הביסיאנית כלהלן, על ידי הוספת 2 משתנים אקראיים :

B – האם התקציב מאוזן?

C – האם אחוז ההגעה למפגשי ההנחיה יגדל?

חשבו : P(B|M,G) ,P(C|B)

המשך השאלה בעמוד הבא

$$
\begin{aligned}
&Action(\text{ACTION}{:}Go(x,y),\ \text{PRECOND}{:}At(Shakey,x) \wedge In(x,r) \wedge In(y,r),\\
&\quad \text{EFFECT}{:}At(Shakey,y) \wedge \neg(At(Shakey,x)))\\
&Action(\text{ACTION}{:}Push(b,x,y),\ \text{PRECOND}{:}At(Shakey,x) \wedge Pushable(b),\\
&\quad \text{EFFECT}{:}At(b,y) \wedge At(Shakey,y) \wedge \neg At(b,x) \wedge \neg At(Shakey,x))\\
&Action(\text{ACTION}{:}ClimbUp(b),\ \text{PRECOND}{:}At(Shakey,x) \wedge At(b,x) \wedge Climbable(b),\\
&\quad \text{EFFECT}{:}On(Shakey,b) \wedge \neg On(Shakey,Floor))\\
&Action(\text{ACTION}{:}ClimbDown(b),\ \text{PRECOND}{:}On(Shakey,b),\\
&\quad \text{EFFECT}{:}On(Shakey,Floor) \wedge \neg On(Shakey,b))\\
&Action(\text{ACTION}{:}TurnOn(l),\ \text{PRECOND}{:}On(Shakey,b) \wedge At(Shakey,x) \wedge At(l,x),\\
&\quad \text{EFFECT}{:}TurnedOn(l))\\
&Action(\text{ACTION}{:}TurnOff(l),\ \text{PRECOND}{:}On(Shakey,b) \wedge At(Shakey,x) \wedge At(l,x),\\
&\quad \text{EFFECT}{:}\neg TurnedOn(l))
\end{aligned}
$$

The initial state is:

$$
\begin{aligned}
&In(Switch_1, Room_1) \wedge In(Door_1, Room_1) \wedge In(Door_1, Corridor)\\
&In(Switch_1, Room_2) \wedge In(Door_2, Room_2) \wedge In(Door_2, Corridor)\\
&In(Switch_1, Room_3) \wedge In(Door_3, Room_3) \wedge In(Door_3, Corridor)\\
&In(Switch_1, Room_4) \wedge In(Door_4, Room_4) \wedge In(Door_4, Corridor)\\
&In(Shakey, Room_3) \wedge At(Shakey, X_S)\\
&In(Box_1, Room_1) \wedge In(Box_2, Room_1) \wedge In(Box_3, Room_1) \wedge In(Box_4, Room_1)\\
&Climbable(Box_1) \wedge Climbable(Box_2) \wedge Climbable(Box_3) \wedge Climbable(Box_4)\\
&Pushable(Box_1) \wedge Pushable(Box_2) \wedge Pushable(Box_3) \wedge Pushable(Box_4)\\
&At(Box_1, X_1) \wedge At(Box_2, X_2) \wedge At(Box_3, X_3) \wedge At(Box_4, X_4)\\
&TurnwdOn(Switch_1) \wedge TurnedOn(Switch_4)
\end{aligned}
$$

A plan to achieve the goal is:

$$
\begin{aligned}
&Go(X_S, Door_3)\\
&Go(Door_3, Door_1)\\
&Go(Door_1, X_2)\\
&Push(Box_2, X_2, Door_1)\\
&Push(Box_2, Door_1, Door_2)\\
&Push(Box_2, Door_2, Switch_2)
\end{aligned}
$$

11.13 The original STRIPS program was designed to control Shakey the robot. Figure 11.17 shows a version of Shakey's world consisting of four rooms lined up along a corridor, where each room has a door and a light switch.

The actions in Shakey's world include moving from place to place, pushing movable objects (such as boxes), climbing onto and down from rigid objects (such as boxes), and turning light switches on and off. The robot itself was never dexterous enough to climb on a box or toggle a switch, but the STRIPS planner was capable of finding and printing out plans that were beyond the robot's abilities. Shakey's six actions are the following:

- $Go(x, y)$, which requires that Shakey be at x and that x and y are locations in the same room. By convention a door between two rooms is in both of them.
- Push a box b from location x to location y within the same room: $Push(b, x, y)$. We will need the predicate Box and constants for the boxes.
- Climb onto a box: $ClimbUp(b)$; climb down from a box: $ClimbDown(b)$. We will need the predicate On and the constant $Floor$.
- Turn a light switch on: $TurnOn(s)$; turn it off: $TurnOff(s)$. To turn a light on or off, Shakey must be on top of a box at the light switch's location.

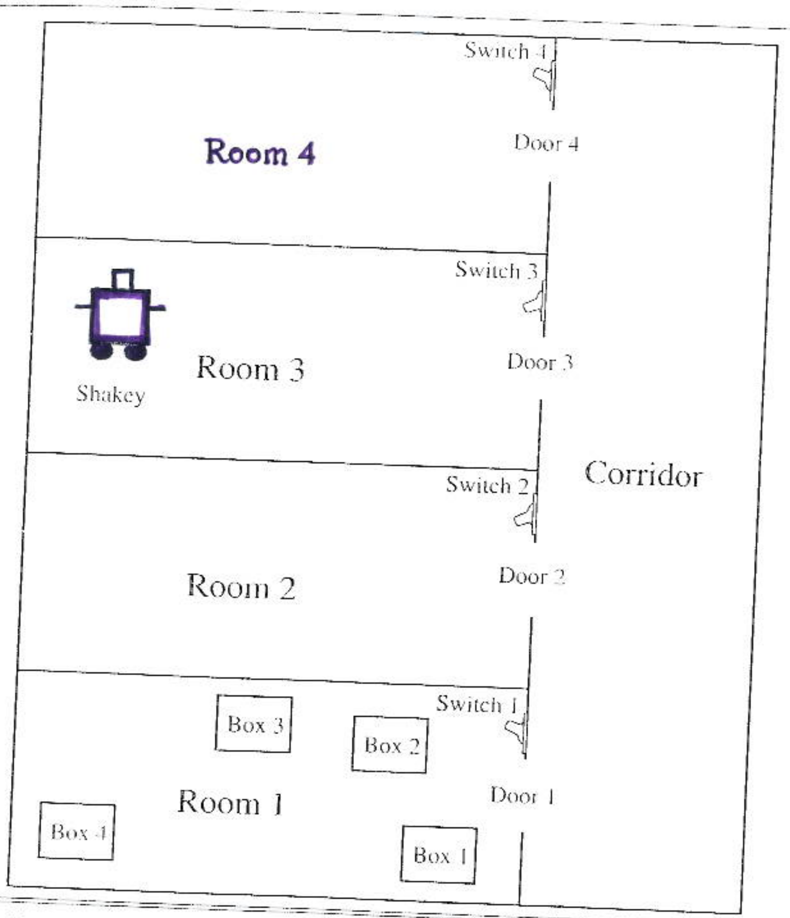


Figure 11.17 Shakey's world. Shakey can move between landmarks within a room, can pass through the door between rooms, can climb climbable objects and push pushable objects, and can flip light switches.

Describe Shakey's six actions and the initial state from Figure 11.17 in STRIPS notation. Construct a plan for Shakey to get Box_2 into $Room_2$.

11.4 The monkey-and-bananas problem is faced by a monkey in a laboratory with some bananas hanging out of reach from the ceiling. A box is available that will enable the monkey to reach the bananas if he climbs on it. Initially, the monkey is at A, the bananas at B, and the box at C. The monkey and box have height Low, but if the monkey climbs onto the box he will have height $High$, the same as the bananas. The actions available to the monkey include Go from one place to another, $Push$ an object from one place to another, $ClimbUp$ onto or $ClimbDown$ from an object, and $Grasp$ or $Ungrasp$ an object. Grasping results in holding the object if the monkey and object are in the same place at the same height.

a. Write down the initial state description.

b. Write down STRIPS-style definitions of the six actions.

c. Suppose the monkey wants to fool the scientists, who are off to tea, by grabbing the bananas, but leaving the box in its original place. Write this as a general goal (i.e., not assuming that the box is necessarily at C) in the language of situation calculus. Can this goal be solved by a STRIPS-style system?

d. Your axiom for pushing is probably incorrect, because if the object is too heavy, its position will remain the same when the $Push$ operator is applied. Is this an example of the ramification problem or the qualification problem? Fix your problem description to account for heavy objects.

a. The initial state is:

$$At(Monkey, A) \land At(Bananas, B) \land At(Box, C) \land$$
$$Height(Monkey, Low) \land Height(Box, Low) \land Height(Bananas, High) \land$$
$$Pushable(Box) \land Climbable(Box)$$

b. The actions are:

$Action(\text{ACTION:}Go(x,y), \text{PRECOND:}At(Monkey,x),$
$\quad \text{EFFECT:}At(Monkey,y) \land \neg(At(Monkey,x)))$

$Action(\text{ACTION:}Push(b,x,y), \text{PRECOND:}At(Monkey,x) \land Pushable(b),$
$\quad \text{EFFECT:}At(b,y) \land At(Monkey,y) \land \neg At(b,x) \land \neg At(Monkey,x))$

$Action(\text{ACTION:}ClimbUp(b),$
$\quad \text{PRECOND:}At(Monkey,x) \land At(b,x) \land Climbable(b),$
$\quad \text{EFFECT:}On(Monkey,b) \land \neg Height(Monkey,High))$

$Action(\text{ACTION:}Grasp(b),$
$\quad \text{PRECOND:}Height(Monkey,h) \land Height(b,h)$
$\qquad \land At(Monkey,x) \land At(b,x),$
$\quad \text{EFFECT:}Have(Monkey,b))$

$Action(\text{ACTION:}ClimbDown(b),$
$\quad \text{PRECOND:}On(Monkey,b) \land Height(Monkey,High),$
$\quad \text{EFFECT:} \neg On(Monkey,b) \land \neg Height(Monkey,High)$
$\qquad \land Height(Monkey,Low)$

$Action(\text{ACTION:}UnGrasp(b), \text{PRECOND:}Have(Monkey,b),$
$\quad \text{EFFECT:}\neg Have(Monkey,b))$

c. In situation calculus, the goal is a state s such that:

$$Have(Monkey, Bananas, s) \land (\exists x \;\; At(Box, x, s_0) \land At(Box, x, s))$$

In STRIPS, we can only talk about the goal state; there is no way of representing the fact that there must be some relation (such as equality of location of an object) between two states within the plan. So there is no way to represent this goal.

d. Actually, we did include the $Pushable$ precondition. This is an example of the qualification problem.

TABLE 4.1: Data for Height Classification

Name	Gender	Height	Output1	Output2
Kristina	F	1.6 m	Short	Medium
Jim	M	2 m	Tall	Medium
Maggie	F	1.9 m	Medium	Tall
Martha	F	1.88 m	Medium	Tall
Stephanie	F	1.7 m	Short	Medium
Bob	M	1.85 m	Medium	Medium
Kathy	F	1.6 m	Short	Medium
Dave	M	1.7 m	Short	Medium
Worth	M	2.2 m	Tall	Tall
Steven	M	2.1 m	Tall	Tall
Debbie	F	1.8 m	Medium	Medium
Todd	M	1.95 m	Medium	Medium
Kim	F	1.9 m	Medium	Tall
Amy	F	1.8 m	Medium	Medium
Wynette	F	1.75 m	Medium	Medium

$\frac{6}{15}\cdot 0.4392 + \frac{9}{15}\cdot 0.2764 = 0.3415$

Claude Shannon

אנטרופיה

$H = -\sum_i p(i)\cdot \lg p(i)$

$S=4$
$M=8$
$T=3$

$-\left(\frac{4}{15}\lg\frac{4}{15} + \frac{8}{15}\lg\frac{8}{15} + \frac{3}{15}\cdot\lg\frac{3}{15}\right) = 0.4384$

Gender

	M (6)	F (9)
S	1	3
M	2	6
T	3	0

F: $-\left(\frac{3}{9}\lg\frac{3}{9} + \frac{6}{9}\lg\frac{6}{9}\right) = 0.2764$

M: $-\left(\frac{1}{6}\lg\frac{1}{6} + \frac{2}{6}\lg\frac{2}{6} + \frac{3}{6}\cdot\lg\frac{3}{6}\right) = 0.4392$

Let $H\left(\frac{1}{n}, \frac{1}{n}, \cdots, \frac{1}{n}\right) = A(n)$. From condition (3) we can decompose a choice from s^m equally likely possibilities into a series of m choices each from s equally likely possibilities and obtain

$$A(s^m) = m\,A(s).$$

Similarly

$$A(t^n) = n\,A(t).$$

We can choose n arbitrarily large and find an m to satisfy

$$s^m \leq t^n < s^{(m+1)}.$$

Thus, taking logarithms and dividing by $n \log s$,

$$\frac{m}{n} \leq \frac{\log t}{\log s} \leq \frac{m}{n} + \frac{1}{n} \text{ or } \left| \frac{m}{n} - \frac{\log t}{\log s} \right| < \epsilon$$

where ϵ is arbitrarily small. Now from the monotonic property of $A(n)$,

$$A(s^m) \leq A(t^n) \leq A(s^{m+1})$$
$$m\,A(s) \leq nA(t) \leq (m+1)\,A(s).$$

Hence, dividing by $nA(s)$,

$$\frac{m}{n} \leq \frac{A(t)}{A(s)} \leq \frac{m}{n} + \frac{1}{n} \text{ or } \left| \frac{m}{n} - \frac{A(t)}{A(s)} \right| < \epsilon$$

$$\left| \frac{A(t)}{A(s)} - \frac{\log t}{\log s} \right| \leq 2\epsilon \qquad A(t) = K \log t$$

where K must be positive to satisfy (2).

Now suppose we have a choice from n possibilities with commeasurable probabilities $p_i = \frac{n_i}{\Sigma n_i}$ where the n_i are integers. We can break down a choice from Σn_i possibilities into a choice from n possibilities with probabilities $p_1, \cdots, p_n$ and then, if the ith was chosen, a choice from n_i with equal probabilities. Using condition (3) again, we equate the total choice from Σn_i as computed by two methods

$$K \log \Sigma n_i = H(p_1, \cdots, p_n) + K\Sigma\, p_i \log n_i.$$

Hence

$$H = K[\Sigma p_i \log \Sigma n_i - \Sigma p_i \log n_i]$$
$$= -K\Sigma p_i \log \frac{n_i}{\Sigma n_i} = -K\Sigma p_i \log p_i.$$

If the p_i are incommeasurable, they may be approximated by rationals and the same expression must hold by our continuity assumption. Thus the expression holds in general. The choice of coefficient K is a matter of convenience and amounts to the choice

- הפגישה נמשכה כל היום ללא הפסקה
- כל אדם נוכח בפגישה במשך זמן אחד רציף
- Jones היה נוכח בתחילת הפגישה ו- White בסופה
- המנהל Smith היה נוכח, אבל הגיע או אחרי ש- Jones עזב, או ששניהם עזבו באותו זמן
- Brown דיבר עם White בנוכחותו של Smith

שאלה: האם Jones ו-White יכלו להיפגש ?

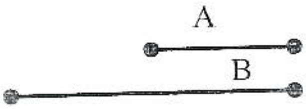
A before B   B after A

A meets B   B is met by A

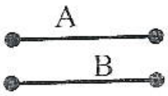
A overlaps B   B is overlapped by A

A starts B   B is started by A

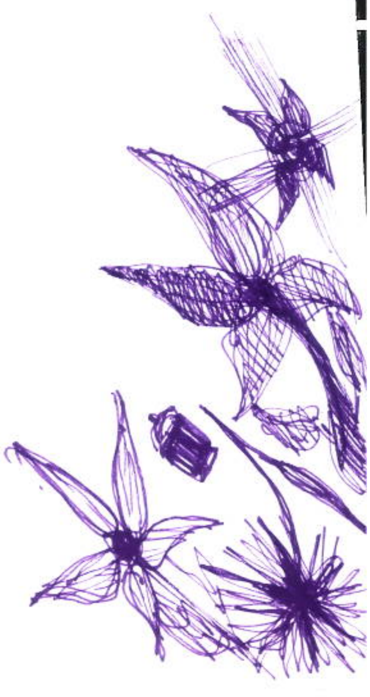
A during B   B contains A



A finishes B   B is finished by A



A equals B

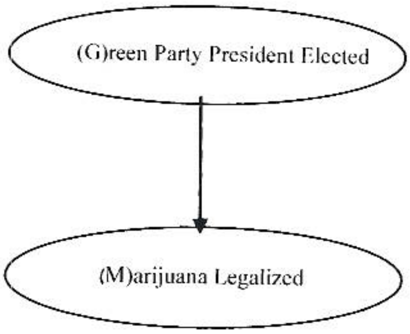


שאלה 3 (30 נק')

כעת תקופת הבחירות העירוניות ויתכן שבעיר סדום יבחר מועמד מפלגת הירוקים. פלוני מאמין שיש סיכוי גבוה יותר שנשיא ממפלגת הירוקים יהפוך את המריחואנה לחוקית לעומת מועמדים ממפלגות אחרות, אבל גם כל נבחר אחר יכול להפוך את המריחואנה לחוקית.

נתאר את המצב בעזרת הרשת הביסיאנית שלהלן :

P(G)
0.1



G	P(M)
t	0.667
f	0.25

א. אמצעי התקשורת הודיעו שהמריחואנה עומדת להיות חוקית אך לא ידוע עדיין מי זכה בבחירות.

מהי ההסתברות $P(G|M)$ לכך שנבחר נשיא ממפלגת הירוקים?

ב. אם יהיה לנו יותר מידע, נוכל לבצע היסקים טובים יותר. נרחיב את הרשת הביסיאנית כלהלן, על ידי הוספת 2 משתנים אקראיים :

B – האם התקציב מאוזן?

C – האם אחוז ההגעה למפגשי ההנחיה יגדל?

חשבו : $P(C|B)$,$P(B|M,G)$

המשך השאלה בעמוד הבא