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T03 Planning and Uncertainty

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Contents

1 Q1

(a) $volume(p_1) = 5 \wedge volume(p_2) = 2$
$\wedge Contains(p_1, 5, S_0) \wedge Contains(p_2, 0, S_0)$

(b) $\forall p, w, s.\ Contains(p, w, s) \wedge w > 0$
$\rightarrow Contains(p, 0, do(empty(p), s))$

$\forall p_1, p_2, w_1, w_2, s.\ p_1 \neq p_2$
$\wedge Contains(p_1, w_1, s) \wedge w_1 > 0$
$\wedge Contains(p_2, w_2, s) \wedge w_2 < volume(p_2)$
$\rightarrow Contains(p_1, w_1 - w_{min}, do(tansfer(p_1, p_2), s))$
$\wedge Contains(p_2, w_2 + w_{min}, do(tansfer(p_1, p_2), s))$
这里 $w_{min} = min(w_1, volume(p_2) - w_2)$

(c) $\exists z, p.\ volume(p) = 2 \wedge Contains(p, 1, z)$

(d)
$do(transfer(p_1, p_2), do(empty(p_2), do(transfer(p_1, p_2), do(empty(p_2), do(transfer(p_1, p_2), S_0)))))$

2 Q2

(a) move(x, y, z)

Pre : { clear(x), clear(z), on(x, y) }

Add : { clear(y), on(x, z) }

Dels : { clear(z), on(x, y) }

moveFromTable(x, y)

Pre : { clear(x), clear(y), onTable(x) }

Add : { on(x, y) }

Dels : { clear(y), onTable(x) }

moveToTable(x, y)

Pre : { clear(x), on(x, y) }

Add : { clear(y), onTable(x) }

Dels : { on(x, y) }

initial KB = { clear(a),
on(a, b),
on(b, c),
onTable(c) }

goal = clear(a) ∧ clear(c)
∧ on(a, b) ∧ onTable(b)
∧ onTable(c)

(b)

S_0	A_0	S_1	A_1	S_2
clear(a)	move(a, b, a)	clear(a)	move(a, a, a)	clear(a)
on(a, b)	moveToTable(a, b)	clear(b)	move(a, a, b)	clear(b)
on(b, c)		on(a, b)	move(a, b, b)	clear(c)
onTable(c)		on(b, c)	move(b, c, a)	on(a, a)
		on(a, a)	move(b, c, b)	on(a, b)
		onTable(a)	moveFromTable(a, a)	on(b, a)
		onTable(c)	moveFromTable(a, b)	on(b, b)
			moveToTable(a, a)	on(b, c)
			moveToTable(b, c)	onTable(a)
				onTable(b)
				onTable(c)

CountActions(G_1, S_2):

$G_1 = \{clear(a), clear(c), on(a, b), onTable(b), onTable(c)\}$

$G_P = \{clear(a), on(a, b), onTable(c)\}$

$G_W = \{clear(c), onTable(b)\}$

$A = \{moveToTable(b, c)\}$

$Pre(A) = \{clear(b), on(b, c)\}$

$G_1 = G_P \cup Pre(A) = \{clear(a), clear(b), on(a, b), on(b, c), onTable(c)\}$

CountActions(G_1, S_1):

$G_1 = \{clear(a), clear(b), on(a, b), on(b, c), onTable(c)\}$

$G_P = \{clear(a), on(a, b), on(b, c), onTable(c)\}$

$G_W = \{clear(b)\}$

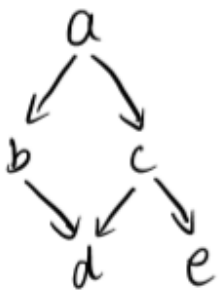
$A = \{moveToTable(a, b)\}$

CountActions(G_0, S_0): return 0

∴ heuristic value = CountActions(G_1, S_2) = 2

3 Q3

(a)



(b) d and e are independent given c

(c) $P(A,B,C,\neg d,e) = P(A)\cdot P(B|A)\cdot P(C|A)\cdot P(\neg d|B,C)\cdot P(e|C)$

$P(a,b,c,\neg d,e) = 0.2\times 0.8\times 0.2\times 0.2\times 0.8 = 0.00512$

$P(a,b,\neg c,\neg d,e) = 0.2\times 0.8\times 0.8\times 0.2\times 0.6 = 0.01536$

$P(a,\neg b,c,\neg d,e) = 0.2\times 0.2\times 0.2\times 0.2\times 0.8 = 0.00128$

$P(a,\neg b,\neg c,\neg d,e) = 0.2\times 0.2\times 0.8\times 0.95\times 0.6 = 0.01824$

$P(\neg a,b,c,\neg d,e) = 0.8\times 0.2\times 0.05\times 0.2\times 0.8 = 0.00128$

$P(\neg a,b,\neg c,\neg d,e) = 0.8\times 0.2\times 0.95\times 0.2\times 0.6 = 0.01824$

$P(\neg a,\neg b,c,\neg d,e) = 0.8\times 0.8\times 0.05\times 0.2\times 0.8 = 0.00512$

$P(\neg a,\neg b,\neg c,\neg d,e) = 0.8\times 0.8\times 0.95\times 0.95\times 0.6 = 0.34656$

$P(\neg d,e) = \Sigma_{abc} P(A,B,C,\neg d,e) = 0.4112$

$P(A,B,C|\neg d,e)$:

A	B	C	P
a	b	c	0.01245136
a	b	¬c	0.03735409
a	¬b	c	0.00311284
a	¬b	¬c	0.04435798
¬a	b	c	0.00311284
¬a	b	¬c	0.04435798
¬a	¬b	c	0.01245136
¬a	¬b	¬c	0.84280156

(d) $P(a,\neg d,e) = \Sigma_{bc} P(a,B,C,\neg d,e)$

$= 0.04$

$P(a|\neg d,e) = \frac{P(a,\neg d,e)}{P(\neg d,e)} = 0.09727626$

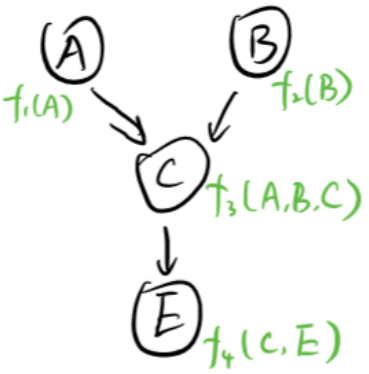
由于 $P(a|\neg d,e) < P(a) = 0.2$

∴患 cancer 的可能性下降了.

4 Q4

(a) 变量D和F是无关的，所以只需考虑右图：

消除顺序：A, B, C

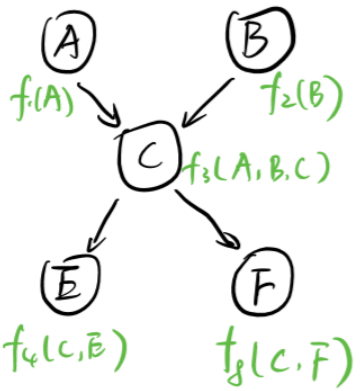


$f_1(A)$		$f_2(B)$		$f_3(A,B,C)$		$f_4(C,E)$	
a	0.9	b	0.2	abc	0.1	ce	0.7
$\neg a$	0.1	$\neg b$	0.8	$ab\neg c$	0.9	$c\neg e$	0.3
				$a\neg bc$	0.8	$\neg ce$	0.2
				$a\neg b\neg c$	0.2	$\neg c\neg e$	0.8
				$\neg abc$	0.7		
				$\neg ab\neg c$	0.3		
				$\neg a\neg bc$	0.4		
				$\neg a\neg b\neg c$	0.6		

消除A $\Sigma_A f_3(A,B,C)f_1(A)$ $f_5(B,C)$		消除B $\Sigma_B f_5(B,C)f_2(B)$ $f_6(C)$		消除C $\Sigma_C f_4(C,E)f_6(C)$ $f_7(E)$	
bc	0.16	c	0.64	e	0.52
$b\neg c$	0.84	$\neg c$	0.36	$\neg e$	0.48
$\neg bc$	0.76				
$\neg b\neg c$	0.24				

$\therefore P(e) = 0.52$

(b) 要计算 $P(e|\neg f)$，则只有 D 是无关的，考虑右图：



这时比前面多了一个 $f_8(C,F)$，首先对 F 进行 restrict：

$f_8(C,F)$		$f_8(C,\neg f)$
		$f_9(C)$
Cf	0.2	C 0.8
$C\neg f$	0.8	$\neg C$ 0.1
$\neg Cf$	0.9	
$\neg C\neg f$	0.1	

之后就是按照 A、B、C 的顺序进行消除。其中对 A 和 B 的消除与之前一模一样，可以重复使用，唯一不同的是对 C 的消除。

消除 C $\sum_C f_4(C,E)f_6(C)f_9(C)$ $f_{10}(E)$	
e	0.3836
$\neg e$	0.1824

$$\therefore P(e|\neg f)=\frac{0.3836}{0.3836+0.1824}=0.67773852$$