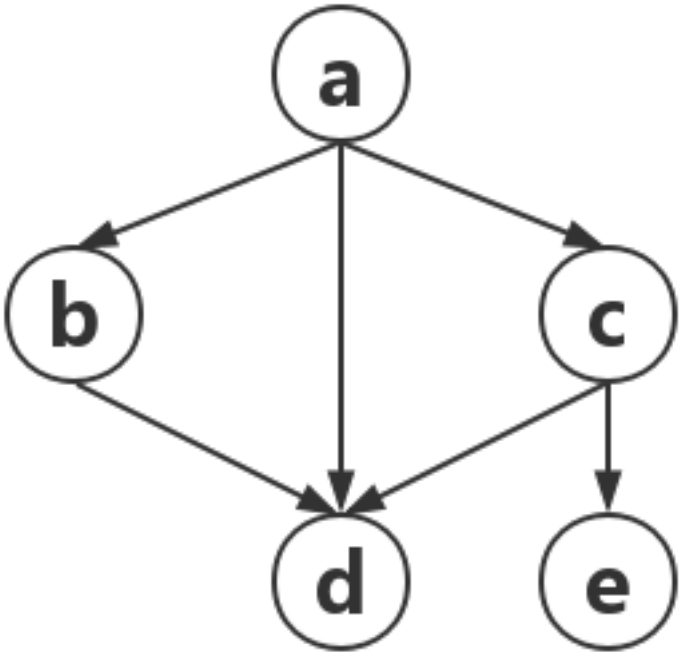
School of Data and Computer Science, Sun Yat-sen University

T03 Planning and Uncertainty

16337110 匡乾, 16337111 赖若潘

2018 年 11 月 4 日

目录



a: addicted to games
b: lack of exercise
c: get low score in the final exam
d: unpopular among classmates
e: rejection of scholarship application

图 1:

1 Q1

2 Q2

(a)

- actions:
  - move(x, a, b):

    Pre:{on(x, a), clear(x), clear(b), smaller(x, b)}

    Adds:{on(x, b), clear(a)}

    Dels:{on(x, a), clear(b)}
  - moveTwo(x, y, a, b):

    Pre:{on(x, y), on(y, a), clear(x), clear(b), smaller(y, b)}

    Adds:{on(y, b), clear(a)}

    Dels:{on(y, a), clear(b)}
- initial KB: $\{on(d_1, d_2), on(d_2, d_3), on(d_3, p_1), clear(d_1), clear(p_2), clear(p_3)\}$
- goal: $\{on(d_1, d_2), on(d_2, d_3), on(d_3, p_3), clear(d_1), clear(p_1), clear(p_2)\}$

(b) Reachability Analysis:

$S_0 = \{on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2), on(d_3, p_1), clear(p_3)\}$

$A_0 = \{[on(d_1, d_2), clear(d_1), clear(p_2), smaller(d_1, p_2)]move(d_1, d_2, p_2)[on(d_1, p_2), clear(d_2)],$

$[on(d_1, d_2), clear(d_1), clear(p_3), smaller(d_1, p_3)]move(d_1, d_2, p_3)[on(d_1, p_3), clear(d_2)],$

$[on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2), smaller(d_2, p_2)]move(d_1, d_2, d_3, p_2)[on(d_2, p_2), clear(d_3)]$

$[on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_3), smaller(d_2, p_3)]move(d_1, d_2, d_3, p_3)[on(d_2, p_3), clear(d_3)]\}$

$S_1 = \{on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2), on(d_3, p_1), clear(p_3), on(d_1, p_2),$

$on(d_1, p_3), clear(d_2), on(d_2, p_2), on(d_2, p_3), clear(d_3)\}$

$A_1 = \{[on(d_3, p_1), clear(d_3), clear(p_3), smaller(d_3, p_3)]move(d_3, p_1, p_3)[on(d_3, p_3), clear(p_1)] \cdots\}$

$S_2 = \{on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2), on(d_3, p_3), clear(p_1), on(d_3, p_1),$

$clear(p_3), on(d_1, p_2), on(d_1, p_3), clear(d_2), on(d_2, p_2), on(d_2, p_3), clear(d_3) \cdots\}$

因为goal $\notin S_1$, goal $\in S_2$, 所以停止, 接下来计算启发式函数的值。

$CountAction(G, S_2)$:

$G_P = \{on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2)\}$

$G_N = \{on(d_3, p_3), clear(p_1)\}$

$A = \{move(d_3, p_1, p_3)\}$

$G_1 = G_P \cup Pre(A) = \{on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2), on(d_3, p_1), clear(d_3), clear(p_3)\}$

$return\ 1 + CountAction(G_1, S_1)$

$CountAction(G_1, S_1)$:

$G_P = \{on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2)\}$

$G_N = \{on(d_3, p_1), clear(d_3), clear(p_3)\}$

$A = \{move(d_1, d_2, d_3, p_2)\}$

$G_2 = G_P \cup Pre(A) = \{on(d_1, d_2), on(d_2, d_3), clear(d_1), clear(p_2)\}$

$return\ 1 + CountAction(G_2, S_0)$

$CountAction(G_2, S_0) = 0$

综上：$CountAction(G, S_2) = 1 + 1 + 0 = 2$

3 Q3

1.

2. 设节点A的因子为$f_1(A)$, 节点B因子为$f_2(B)$, 节点C因子为 $f_3(A,B,C)$, 节点D因子为$f_4(B,D)$, 节点E因子为$f_5(C,E)$, 节点F因子为$f_6(C,F)$

a	0.8
$\neg a$	0.2

b	0.2
$\neg b$	0.8

abc	0.2
$ab\neg c$	0.8
$a\neg bc$	0.7
$a\neg b\neg c$	0.3
$\neg abc$	0.8
$\neg ab\neg c$	0.2
$\neg a\neg bc$	0.4
$\neg a\neg b\neg c$	0.6

bd	0.1
$b\neg d$	0.9
$\neg bd$	0.8
$\neg b\neg d$	0.2

ce	0.8
$c\neg e$	0.2
$\neg ce$	0.1
$\neg c\neg e$	0.9

cf	0.2
$c\neg f$	0.8
$\neg cf$	0.8
$\neg c\neg f$	0.2

表 1: $f_1(A), f_2(B), f_3(A,B,C), f_4(B,D), f_5(C,E), f_6(C,F)$

(a) 计算P(e), 先要计算分布P(E),查询变量为E, 证据变量无, 那么我们只需考虑查询变量E和E的祖先即可,相关变量为E, C, A, B。

设消元顺序为A,B,C。

$A: f_1(A), f_3(A,B,C)$

$B: f_2(B)$

$C: f_5(C,E)$

消去A, 即$f_7(B,C) = \sum_A f_1(A) \times f_3(A,B,C) = f_1(a)f_3(a,B,C) + f_1(\neg a)f_3(\neg a,B,C)$, 见表(2)。

$B: f_2(B), f_7(B,C)$

$C: f_5(C,E)$

消去B, 即$f_8(C) = \sum_B f_2(B) \times f_7(B,C) = f_2(b)f_7(b,C) + f_2(\neg b)f_7(\neg b,C)$,见表(2)。

$C: f_5(C,E), f_8(C)$

消去C, 即$f_9(E) = \sum_C f_5(C,E), f_8(C) = f_5(c,E)f_8(c) + f_5(\neg c,E)f_8(\neg c)$,见表(2)。

因此$P(e) = P(E=e) = f_9(e) = 0.5032$

(b) 计算$P(e|\neg f)$, 要计算分布$P(E|\neg f) = \alpha P(E,\neg F)$, 相关的变量有E和E的祖先A,B,C还有F(因为证据变量F是相关变量C的后代)。

设消元顺序为A,B,C。

首先限制因子, $f_{10}(C) = f_6(C, F=\neg f)$,见图(3)

$A: f_1(A), f_3(A,B,C)$

bc	0.32
$b\neg c$	0.68
$\neg bc$	0.64
$\neg b\neg c$	0.36

c	0.576
$\neg c$	0.424

e	0.5032
$\neg e$	0.4968

表 2: $f_7(B,C), f_8(C), f_9(E)$

$B: f_2(B)$

$C: f_5(C,E), f_{10}(C)$

消去A, 即$f_7(B,C) = \sum_A f_1(A) \times f_3(A,B,C)$, (a)中已经计算出来了，可以直接使用, 见(a)中表(2)。

$B: f_2(B), f_7(B,C)$

$C: f_5(C,E), f_{10}(C)$

消去B, 即$f_8(C) = \sum_B f_2(B) \times f_7(B,C)$, (a)中已经计算出来了，可以直接使用, 见(a)中表(2)。

$C: f_5(C,E), f_{10}(C), f_8(C)$

消去C, 即$f_{11}(E) = \sum_C f_5(C,E) \times f_{10}(C) \times f_8(C)$

最后对$f_{11}(E)$归一化, $f_{12}(E) = \alpha f_{11}(E)$, $\alpha = 1/\sum_E f_{11}(E)$,见表(3)。

因此$P(e|\neg f) = P(E = e|\neg f) = f_{12}(e) = 0.6912$

c	0.8
$\neg c$	0.2

e	0.6912
$\neg e$	0.3088

表 3: $f_{10}(C), f_{12}(E)$