1. Constants:

Red balls - R1, R2, R3

Blue balls - B1, B2, B3

Predicates:

- DiffColor(x, y) where x, y are balls and returns true if they are different color
- ContentP_1 - Check if all balls are blue in P1 and return true
- ContentP2 - Check if all balls are red in P2 and return true
- AddToP1(x, y) - Adds balls to P_1
- AddToP2(x, y) - Adds balls to P_2

KB : $\neg$ContentP1 $\wedge$ $\neg$ContentP2

Action:

- MoveToP2(x, y). Moves x, y from P1 to P2

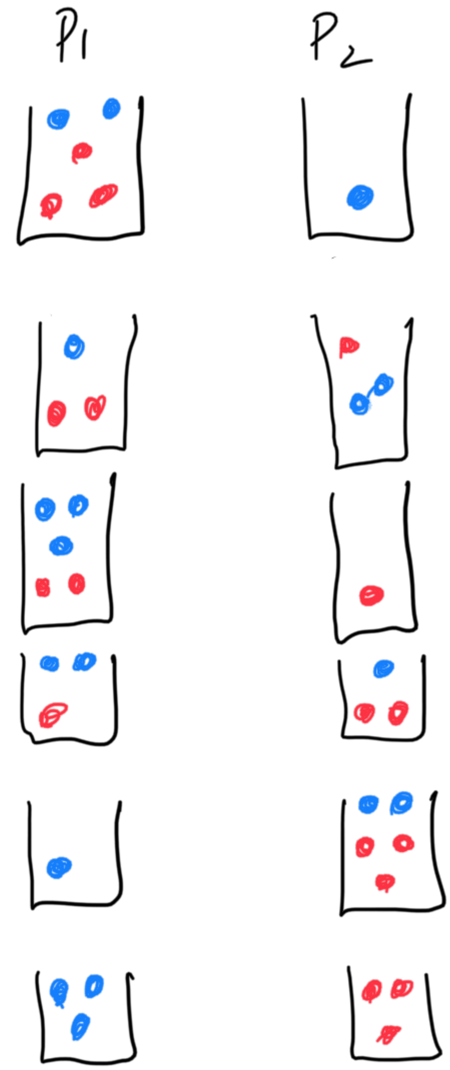
  <u>Precondition</u> - DiffColor(x, y) $\wedge$ $\neg$ContentP2 $\wedge$ $\neg$ContentP1

  <u>Effects</u> - AddToP2(x, y)
- MoveToP1(x, y). Moves x, y from

P_2 to P_1

Precondition - $\neg DiffColor(x,y) \wedge \neg ContentP1 \wedge \neg ContentP2$

Effects - $AddToP_1(x,y)$



MoveToP1(B1, B2)

MoveToP2(R_1, B_1)

MoveToP1(B1, B3)

MoveToP2(R_2, B1)

MoveToP2(R3, B2)

MoveToP1(B1, B2)

Now ContentP1 is true and ContentP2 is true

2. Number of ways to arrange 4 predicate, 3 arguments and 5 constants are -

$[4 \times 5^{1} \quad 4 \times 5^{3}]$

$$[20 \quad 500]$$

States in PDDL $= \sum_{i=0}^{n} {}^{n}C_i = 2^n$

$$\left[\sum^{20} {}^{20}C_i \quad \sum^{500} {}^{500}C_i\right] = \left[2^{20} \quad 2^{500}\right]$$

3-a) $P(\neg Green \mid Truck) = \langle P(\neg Green \mid Truck) \quad P(Green \mid Truck) \rangle$

$$= \left\langle \frac{P(\neg Green \wedge Truck)}{P(Truck)} \quad \frac{P(Green \wedge Truck)}{P(Truck} \right\rangle$$

$$= \alpha \langle P(\neg Green \wedge Truck) \quad P(Green \wedge Truck) \rangle$$

$$= \alpha \langle 0.0504 + 0.1032 \quad 0.0864 \rangle$$

$$= \alpha \langle 0.1536 \quad 0.0864 \rangle$$

α is 4.1667

$$= \langle 0.64 \quad 0.36 \rangle$$

So $P(\neg Green \mid Truck) = 0.64$

b) $P(red) = 0.063 + 0.0441 + 0.0504 + 0.0525$
$= 0.21$

$P(car) = 0.063 + 0.1080 + 0.1290$
$= 0.3$

$P(red) \cdot P(car) = 0.21 \times 0.3 = 0.063 = P(red \wedge car)$

Similary, you can do it for other colors and cars and get the same result that

$P(A) . P(B) = P(A \cap B)$

Therefore vehicle and color are totally independent

4.a) A has 8 values, $B_1 \ldots B_{10}$ have 5 values, C has 6 values

numbers stored in joint distribution table $= 8 \times 5^{10} \times 6$

$= 468750000$

Or we need at least 468749999 numbers to store.

b) B is conditionally independent given A which means $P(B_1|A) \ldots P(B_{10}|A)\, P(A)$

$P(B_i|A)$ where $0 < i \leq 10$ needs 8×5 values

Or 8×4 values at least

So, 10 of these variables need $8 \times 4 \times 10$

$= 320$ values.

P(A) needs 8 or at least 7 values

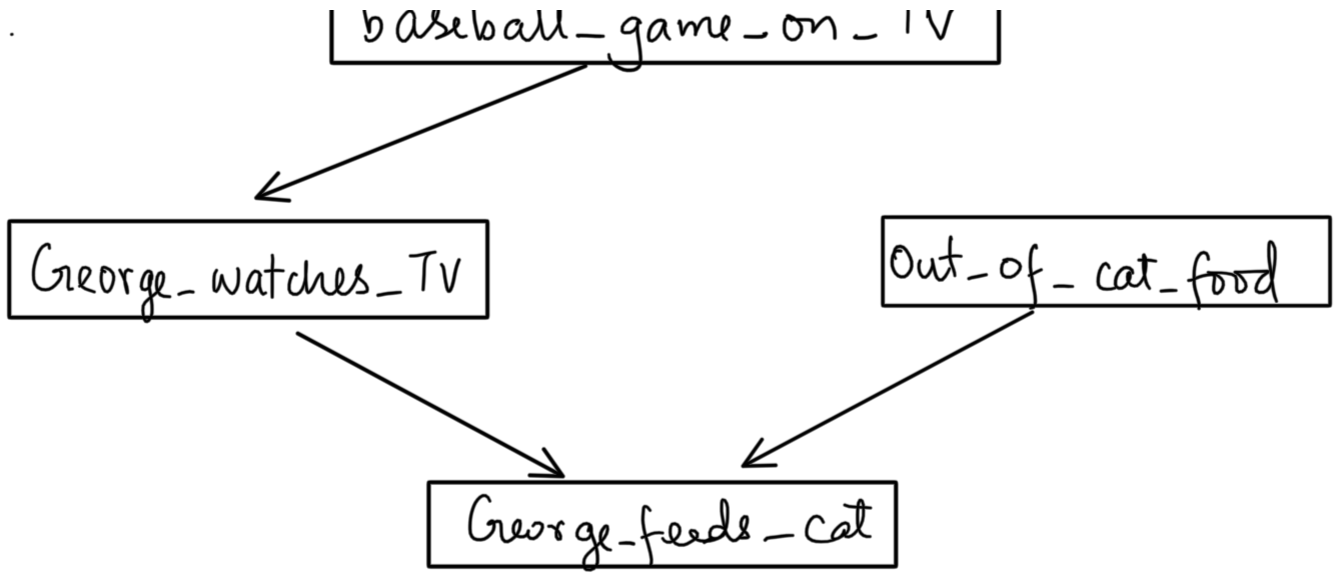
P(C) needs 6 or at least 5 values

Total $= 320 + 7 + 5$

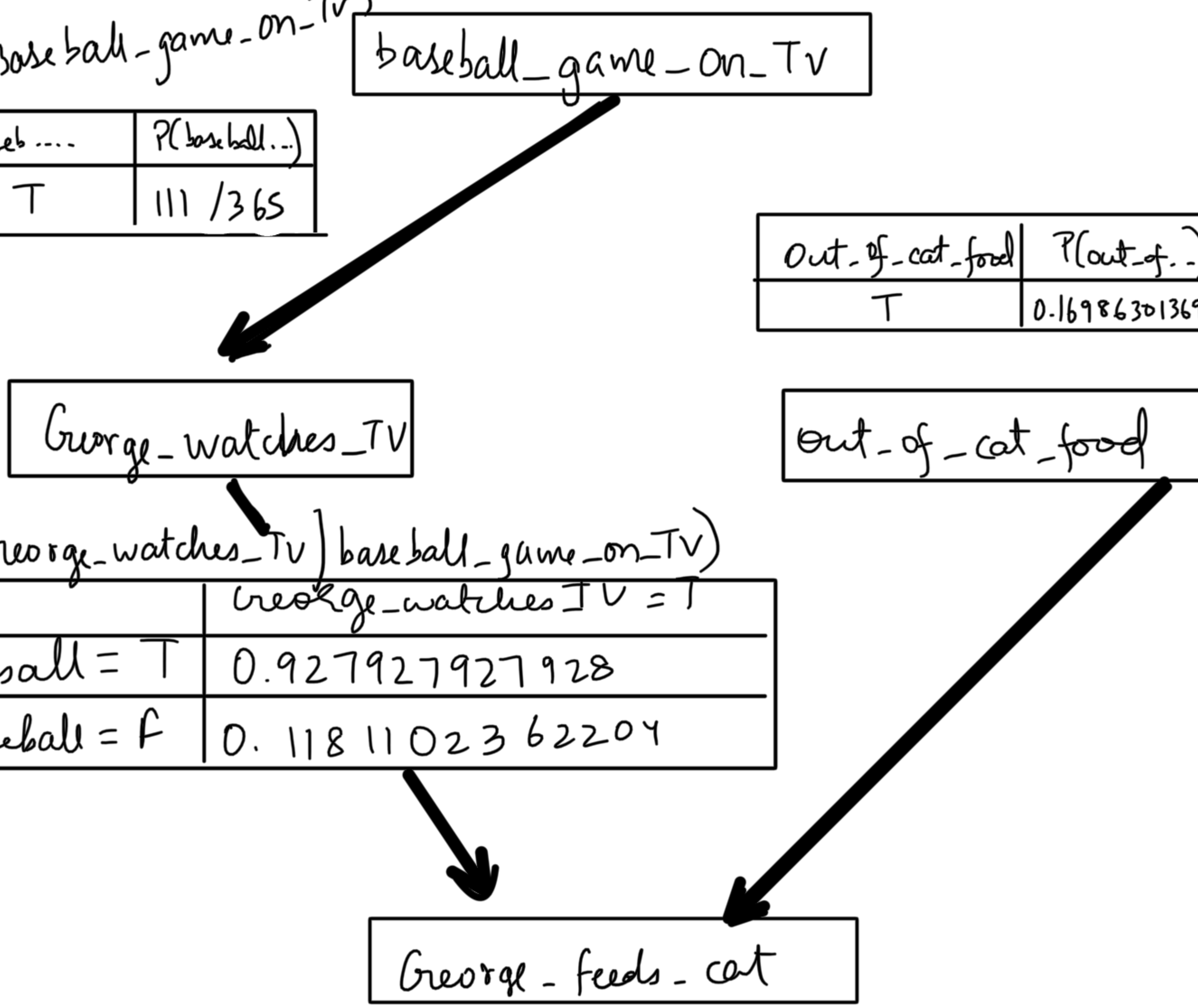
$= 332$ values

5.

5.



6.



P(Baseball_game_on_TV)

baseb....	P(baseball...)
T	111 /365

Out_of_cat_food	P(out_of..)
T	0.169863013 69

P (George_watches_TV | baseball_game_on_TV)

	George_watches_TV = T
baseball = T	0.9279279279 28
baseball = F	0. 118 11023 62204

P (George_feeds_cat | George_watches_TV, out_of_cat_food)

George_watches_TV	out_of_cat_food	George_feeds_cat=T
T	T	0.041666...
T	F	0.7064220183486
F	T	0.3157894736842
F	F	0.9587628865 9

7. P (baseball_game_on_TV | not (George_feeds_cat))

baseball_game_on_TV → B
George_watches_TV → G
Out_of_cat_food → O
George_feeds_cat → C

$$P(B \mid \neg C) \quad \alpha < P(B, \neg C)$$

$$= \sum_{GO} P(B, \neg C, G, O)$$

$$= \sum_{GO} P(B)\, P(O)\, P(G \mid B)\, P(\neg C \mid G, O)$$

$$= P(B)\,P(O)\,P(G \mid B)\,P(\neg C \mid G, O)$$
$$+ P(B)\,P(\neg O)\,P(G \mid B)\,P(\neg C \mid G, \neg O)$$
$$+ P(B)\,P(O)\,P(\neg G \mid B)\,P(\neg C \mid \neg G, O)$$
$$+ P(B)\,P(\neg O)\,P(\neg G \mid B)\,P(\neg C \mid \neg G, \neg O)$$

$= (111/365)(0.16986)(0.92792)(1-0.04166) +$
$(111/365)(1-0.16986)(0.92792)(1-0.70642) +$
$(111/365)(0.16986)(1-0.92792)(1-0.315789) +$
$(111/365)(1-0.16986)(1-0.92792)(1-0.95876)$

$= 0.045935 + 0.06877 + 0.00254 + 0.00075$
$= 0.117995$

$P(\neg C) = (365-276)/365 = 0.243835$
$P(B|\neg C) = 0.117995/0.243835 = 0.48391$

8.a) Markov blanket of node N
- parents - I
- children - R, S
- children's parents - M, O

b) $P(I,D) = P(D)\,P(I|D)$
$= 0.5 \times 0.5$
$= 0.25$

d) $P(M, \neg C | H) = \dfrac{P(M, \neg C, H)}{P(H)}$

$= \dfrac{P(M|H) \cdot P(H|\neg C) \cdot P(\neg C)}{P(H|C)P(C) + P(H|\neg C)P(\neg C)}$

$$P(M|C)P(C) + P(M|\bar{C})P(\bar{C})$$

$$= \frac{0.1 \times 0.1 \times 0.4}{0.6 \times 0.6 + 0.1 \times 0.4} = \frac{0.01 \times 0.4}{0.36 + 0.04}$$

$$= \frac{0.004}{0.4} = 0.01$$