**Part 1: Return of the Race Car**

1.

T (cool, slow, cool) = 1 and R (cool, slow, cool) = +2

T (cool, fast, cool) = 1/3 and R (cool, fast, cool) = +2

T (cool, fast, warm) = 2/3 and R (cool, fast, warm) = +4

T (warm, slow, cool) = 1 and R (warm, slow, cool) = +2

T (warm, fast, off) = 1 and R (warm, fast, off) = 0

T (off, wait, off) = 1 and R (off, wait, off) = 0

V(cool) =

2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Transition | Q(cool, slow) | Q(cool, fast) | Q(warm, slow) | Q(warm, fast) | Q(off, wait) |
| (cool, slow, cool, +2) | 1 | 0 | 0 | 0 | 0 |
| (cool, fast, cool, +2) | 1 | 1.5 | 0 | 0 | 0 |
| (cool, fast, warm, +4) | 1 | 2.75 | 0 | 0 | 0 |
| (warm, slow, cool, +2) | 1 | 2.75 | 2.375 | 0 | 0 |
| (cool, fast, warm, +4) | 1 | 4.5625 | 2.375 | 0 | 0 |
| (warm, fast, off, 0) | 1 | 4.5625 | 2.375 | 0 | 0 |
| (off, wait, off, 0) | 1 | 4.5625 | 2.375 | 0 | 0 |

3.

For state cool, the optimal policy is to go fast, and for state warm, it is better go slow because go fast will result in off state, because there is only one episode for off and end in off, and no reward.

**Part 2: Getting the Job**

1.

P(B, C) = P(+a, B, C) + P(-a, B, C)

The table for P(B, C)

|  |  |  |
| --- | --- | --- |
| B | C | P |
| +b | +c | 0.0125 |
| +b | -c | 0.0375 |
| -b | +c | 0.2375 |
| -b | -c | 0.7125 |

2.

P(B = +b) = 0.05 and P(B = -b) = 0.95

P(C = +c) = 0.25 and P(C = -c) = 0.75

Because P(B,C) = P(B) \* P(C), B is independent of C.

3.

P(A=+a) = 0+0.0025+0.1875+0.6125=0.8025

4.

P(B=+b | A=+a) = P(+b, +a) / P(+a) = 0.0025 / 0.8025 = 1 / 321 0.0031

5.

 P(B = +b | A = +a, C = -c) = P(+b, +a, -c) / P(+a, -c) = 0.0025 / (0.0025 + 0.6125) = 1 / 246 0.0041

The chance of MTA delays is now higher than before, because this time, the employer infers the weather is nice. And train delays and weather are no longer independent given you arrived on time. In this case, weather is eliminated for the arrival, the chance of MTA delays is now higher.

**Part 3: Autonomy for the Car!**

1.

|  |  |  |
| --- | --- | --- |
|  |  | P() |
| Cool | Cool | 0.125 |
| Cool | Warm | 0.375 |
| Warm | Cool | 0.1 |
| Warm | Warm | 0.3 |
| Warm | Off | 0.1 |

2.

P() =

Therefore, P(

P(

P(

3.

Because given the present state, past and future states are independent. and are conditionally independent given

P() = P(), which is the same as policy

|  |  |  |
| --- | --- | --- |
|  |  | P() |
| Cool | Cool | 0.25 |
| Cool | Warm | 0.75 |
| Warm | Cool | 0.2 |
| Warm | Warm | 0.6 |
| Warm | Off | 0.2 |
| Off | Warm | 0.2 |
| Off | Off | 0.8 |

For P()

and are conditional independent with

P() = P() = P() / P()

|  |  |  |
| --- | --- | --- |
|  |  | P() |
| Cool | Cool | 0.125/0.225 = 0.56 |
| Cool | Warm | 0.375/0.675 = 0.56 |
| Warm | Cool | 0.1/0.225 = 0.44 |
| Warm | Warm | 0.3/0.675 = 0.44 |
| Warm | Off | 0.1/0.1 = 1 |

4.

After many transitions, we end up with a stationary distribution, independent of initial distribution, that no longer changers:

(Cool) = 0.25 \* (Cool) + 0.2 \* (Warm)

(Warm) = 0.75 \* (Cool) + 0.6 \* (Warm) + 0.2 \*(Off)

(Off) = 0.2 \* (Warm) + 0.8 \* (Off)

Also, (Cool) + (Warm) + (Off) = 1

(Cool) = 2/17

(Warm) = 15/34

(Off) = 15/34

**Part 4: Where is the robot?**

1.

Emissions:

Because for state (1,0), there are two obstacles S, C adjacent to the robot

P( = 1/2

P( = 1/2

Transitions:

The robot can only move top or stay put because of obstacles.

P( = 1/2

P( = 1/2

2.

As we only consider the nonzero belief state probabilities:

P( = P(/P =

= (1/7 \* 1, 1/7 \* 1, 1/7 \* 1) = (1/3, 1/3, 1/3) after normalization

when

3.

First, push belief through time (make prediction about the future)

P( =

P( = 1/3 \* 1/3 = 1/9

P( = 1/3 \* 1/3 + 1/3 \* 1/3 = 2/9

P( = 1/3 \* 1/3 + 1/3 \* 1/3= 2/9

P( = 1/3 \* 1/3 + 1/3 \* 1/3= 2/9

P( = 1/3 \* 1/3= 1/9

P( = 1/3 \* 1/3= 1/9

Then, update with new evidence to find new belief in the state:

P() = P(

Therefore,

P( =

= = (2/5,2/5,1/5) after normalization

4.

The state for is (1,1)

Because for , there are only three possible states (1,2), (2,2) or (3,1). And the new evidence is sofa, which can only be (1,1) that is state (1,2) moves down

5.

From part 4, P( = 1

P(

=P()

=P(sofa| P(

=(1 \* 1/4, 1 \* 1/4)

=(1/2, 1/2)