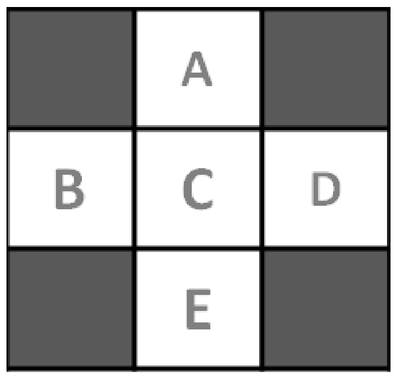
Exam Prep 6

1 Learning in Gridworld

Consider the example gridworld that we looked at in lecture. We would like to use TD learning and q-learning to find the values of these states.



Suppose that we have the following observed transitions:
(B, East, C, 2), (C, South, E, 4), (C, East, A, 6), (B, East, C, 2)

The initial value of each state is 0. Assume that $\gamma = 1$ and $\alpha = 0.5$.

(a) What are the learned values from TD learning after all four observations?

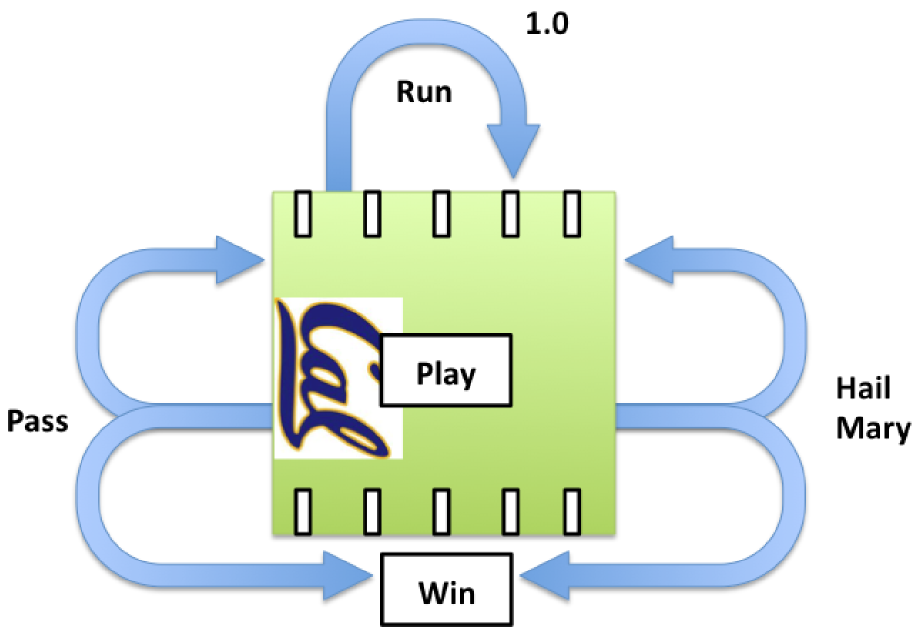
(b) What are the learned Q-values from Q-learning after all four observations?

Q2. MDPs and RL: Go Bears!

Cal's Football team is playing against UCLA for the big homecoming game Saturday night. With a lot of losses in the season so far, Cal needs to switch up their strategy to get any hope of winning this game.

Luckily, the Quarterback (Joe) is a star student in CS188 and has decided to model the game as a Markov Decision Process. There are only two states – the *Play* state (shown as the field in the diagram) and the *Win* State. Although the connectivity of the states is known, the probabilities for each are not.

There are no actions available from the *Win* state – the game simply ends.



From the *Play* state there are three actions: *Run*, *Pass*, and *HailMary*. The connectivity of each action to the two states is shown above.

Reward Values:

State	Action	State'	R(s,a,s')
Play	Run	Play	2
Play	Pass	Play	4
Play	Pass	Win	10
Play	Hail Mary	Play	0
Play	Hail Mary	Win	100

(a) Learning Values Joe wants to learn the value of the play state so he can estimate the outcome of the game. He uses a discount factor of 0.5 for all questions below.

(i) Joe first uses temporal difference value learning to learn the value of the *play* state. After initializing his beliefs to 0, he sees two episodes while in tape review. With a learning rate α of 0.5 what value of the state *play* does he learn?

State	Action	State'
Play	Run	Play
Play	Hail Mary	Play

$$V(play) =$$

(ii) Coach Tedford decides to give Joe a fixed policy instead:

$$\pi(s) \quad = \quad Run$$

What value for the state *play* would Joe calculate if he ran value iteration until convergence? Keep in mind that $\sum_{n=0}^{\infty}(\frac{1}{2})^n = 2 - (\frac{1}{2})^n = 1 + 0.5 + 0.25 + 0.125 + ...$

$$V^{\pi}(play) \quad =$$

(b) Game Time Joe watches the next lecture video from class and now wants to use Q-learning to compute his optimal strategy.

(i) First Joe uses temporal difference Q-learning to learn the values of the Q nodes. He sees three episodes during the first quarter:

State	Action	State'
Play	Run	Play
Play	Hail Mary	Play
Play	Pass	Win

Update the Q node values after processing each episode (in order). Use a learning rate of 0.5 and a discount rate of 0.5.

State	Action	$Q(s,a)$
Play	Run	
Play	Hail Mary	
Play	Pass	

(c) Q learning is going well, but it's taking too much time. Thankfully Oski shows up with some special information – he has watched so many games that he know's the true transition probabilities! Here they are:

State	Action	State'	R(s,a,s')	T(s,a,s')
Play	Run	Play	2	1.0
Play	Pass	Play	4	0.5
Play	Pass	Win	10	0.5
Play	Hail Mary	Play	0	0.9
Play	Hail Mary	Win	100	0.1

(i) Now with these probabilities, what is the optimal policy when there is one time step left? The value?

$$\pi_{k=1}(play) =$$

$$V_{k=1}(play) =$$

(ii) For two time steps left, what is the optimal policy with discount factor 0.5? Hint: you can use your value above to aid in this computation.

$$\pi_{k=2}(play) =$$

$$V_{k=2}(play) =$$