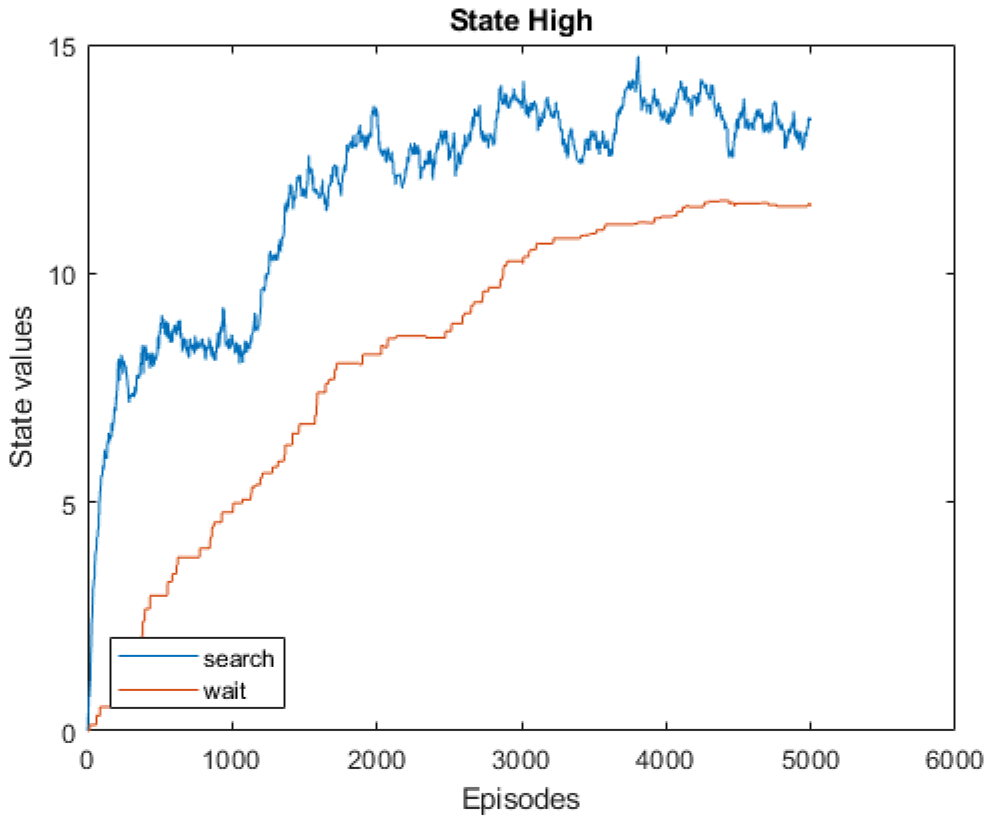
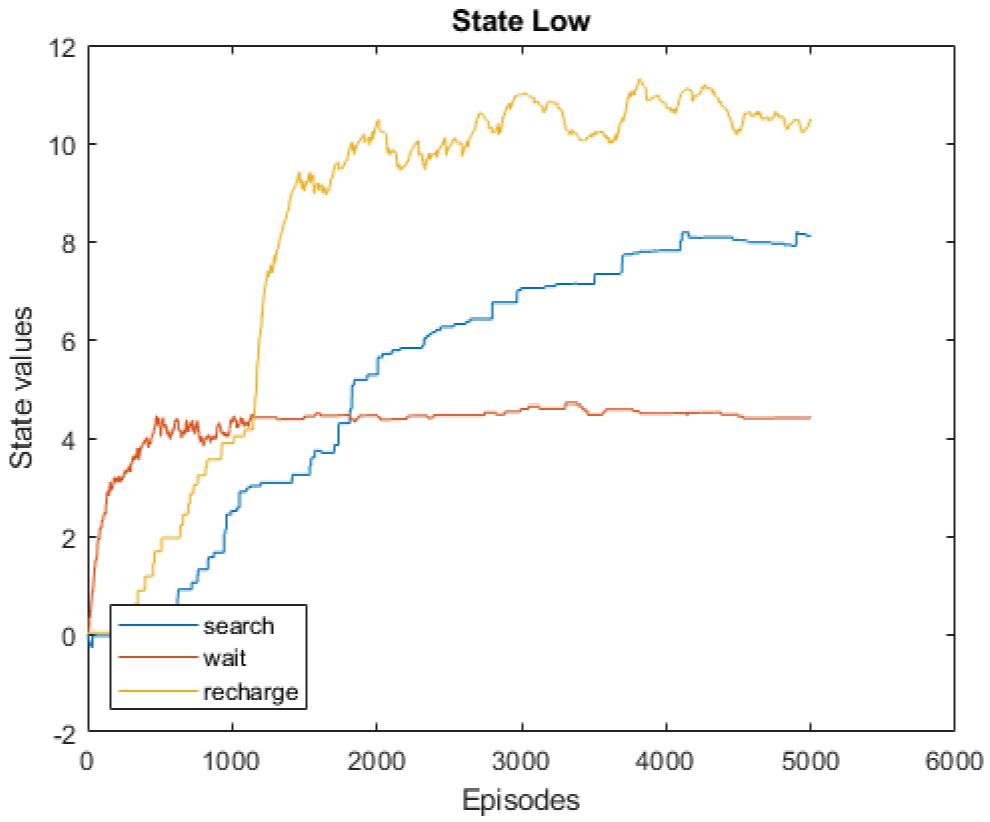
```
% Achyuth Nandikotkur
% V00975928
% ECE-559B
% October 30, 2021

% Question 4

clear;
clc;

global returns qvector searchrewards waitrewards startState
 actionsAtHigh actionsAtLow stepsize epsilon;

% To store average returns
% high - low
qvaluehighsearch = [0];
qvaluehighwait = [0];

qvaluelowsearch = [0];
qvaluelowwait = [0];
qvaluelowrecharge = [0];

Steps = 5000;

stepsize = 0.05;
epsilon = 0.1;

searchrewards = [3, 4, 5, 6];
waitrewards = [0, 1, 2];


loop = 1;
counterhigh = 0;
counterlow = 0;
% returns{0} high
% returns{1} low
returns = [0 0];

for outerloop = 1: Steps
    % selecting initial state as high = 1 or low = 2 with equal
 probability
    sequence = cell(1, 2);
    for k1 = 1:2
        sequence{k1}.state = 0;
        sequence{k1}.action = 0;
        sequence{k1}.reward = 0;
    end

    % Selecting initial state randomly
    sequence{1}.state = randsample([1, 2], 1, true, [0.5, 0.5]);

    % Selecting initial action
    epsgreedy = rand;

    % Greedily
    if(epsgreedy <= (1 - epsilon))
        % If in state high
        if(sequence{1}.state == 1)
            % choosing greedily
            [maxValuedActions, I] = max([qvaluehighsearch(end),
qvaluehighwait(end)]);

            % Tie breaking between different same max valued actions
            sameValueActions = find([qvaluehighsearch(end),
qvaluehighwait(end)] == maxValuedActions);
            r = randi(length(sameValueActions));
            sequence{1}.action = sameValueActions(r);
        else
            % choosing greedily
            [maxValuedActions, I] = max([qvaluelowsearch(end),
qvaluelowwait(end), qvaluelowrecharge(end)]);

            % Tie breaking between different same max valued actions
            sameValueActions = find([qvaluelowsearch(end),
qvaluelowwait(end), qvaluelowrecharge(end)] == maxValuedActions);
            r = randi(length(sameValueActions));
            sequence{1}.action = sameValueActions(r);
        end
    else
        % Randomly with epsilon probability

        if(sequence{1}.state == 1)
            % if initial state is high, select search or wait randomly
            sequence{1}.action = randsample([1, 2], 1);
        else
            % if initial state is low, select search or wait or
recharge randomly
            sequence{1}.action = randsample([1, 2, 3], 1);
        end
    end


    % Determining reward and next state
    if(sequence{1}.state == 1)
        % action can be search = 1, wait = 2;
        if sequence{1}.action == 1
          sequence{1+1}.state = randsample([1, 2],1, true, [0.25,
0.75]);
          sequence{1}.reward =  randsample(searchrewards,1, true,
[1/4, 1/4, 1/4, 1/4]);
        else
          sequence{1}.reward =  randsample(waitrewards,1, true, [1/3,
1/3, 1/3]);
          sequence{1+1}.state = 1;
        end
    else
```

```
        % if in state low
        % action can be search = 1, wait = 2; recharge = 3;
        if sequence{1}.action == 1
          sequence{1+1}.state = randsample([2, 1], 1, true, [0.25, 
0.75]);
          if(sequence{1+1}.state == 2)
              sequence{1}.reward =  randsample(searchrewards,1, true, 
[1/4, 1/4, 1/4, 1/4]);
          else
              sequence{1}.reward = -3;
          end
        elseif(sequence{1}.action == 2)
          sequence{1}.reward =  randsample(waitrewards,1, true, [1/3, 
1/3, 1/3]);
          sequence{1+1}.state = 2;
        else
           sequence{1}.reward = 0;
           sequence{1+1}.state = 1;
        end
    end

    epsgreedy = rand;
    if(epsgreedy < (1 - epsilon))
        if(sequence{1+1}.state == 1)
            % choosing greedily
            [maxValuedActions, I] = max([qvaluehighsearch(end), 
qvaluehighwait(end)]);

            % Tie breaking between different same max valued actions
            sameValueActions = find([qvaluehighsearch(end), 
qvaluehighwait(end)] == maxValuedActions);
        else
            % choosing greedily
            [maxValuedActions, I] = max([qvaluelowsearch(end), 
qvaluelowwait(end), qvaluelowrecharge(end)]);

            % Tie breaking between different same max valued actions
            sameValueActions = find([qvaluelowsearch(end), 
qvaluelowwait(end), qvaluelowrecharge(end)] == maxValuedActions);
        end

        r = randi(length(sameValueActions));

        sequence{1+1}.action = sameValueActions(r);
    else
        if(sequence{1+1}.state == 1)
            sequence{1+1}.action = randsample([1, 2], 1);
        else
            sequence{1+1}.action = randsample([1, 2, 3], 1);
        end
    end

    if(sequence{1}.state == 1)
        % Choosing to search
        if(sequence{1}.action == 1)
            if(sequence{1+1}.state == 1 && sequence{1+1}.action == 1)
                temp = qvaluehighsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluehighsearch(end)) -
qvaluehighsearch(end));
                qvaluehighsearch = [qvaluehighsearch; temp];
            elseif(sequence{1+1}.state == 1 && sequence{1+1}.action ==
2)
                temp = qvaluehighsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluehighwait(end)) -
qvaluehighsearch(end));
                qvaluehighsearch = [qvaluehighsearch; temp];
            elseif(sequence{1+1}.state == 2 && sequence{1+1}.action ==
1)
                temp = qvaluehighsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluelowsearch(end)) -
qvaluehighsearch(end));
                qvaluehighsearch = [qvaluehighsearch; temp];
            elseif(sequence{1+1}.state == 2 && sequence{1+1}.action ==
2)
                temp = qvaluehighsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluelowwait(end)) -
qvaluehighsearch(end));
                qvaluehighsearch = [qvaluehighsearch; temp];
            elseif(sequence{1+1}.state == 2 && sequence{1+1}.action ==
3)
                temp = qvaluehighsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluelowrecharge(end)) -
qvaluehighsearch(end));
                qvaluehighsearch = [qvaluehighsearch; temp];
            end
            qvaluehighwait = [qvaluehighwait; qvaluehighwait(end)];

        % Choosing to wait
        elseif(sequence{1}.action == 2)
            % Next step will be high, and two actions possible, search
            % and wait again
            if(sequence{1+1}.action == 1)
                temp = qvaluehighwait(end) + stepsize *
(sequence{1}.reward + (0.8 * qvaluehighsearch(end)) -
qvaluehighwait(end));
                qvaluehighwait = [qvaluehighwait; temp];
            else
                temp = qvaluehighwait(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluehighwait(end)) -
qvaluehighwait(end));
                qvaluehighwait = [qvaluehighwait; temp];
            end
             qvaluehighsearch = [qvaluehighsearch;
qvaluehighsearch(end)];
        end

        qvaluelowsearch = [qvaluelowsearch; qvaluelowsearch(end)];
        qvaluelowwait = [qvaluelowwait; qvaluelowwait(end)];
```

```
       qvaluelowrecharge = [qvaluelowrecharge;
qvaluelowrecharge(end)];
   else
       % At state low

       % Choosing to search
       if(sequence{1}.action == 1)
           if(sequence{1+1}.state == 1 && sequence{1+1}.action == 1)
               temp = qvaluelowsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluehighsearch(end)) -
qvaluelowsearch(end));
               qvaluelowsearch = [qvaluelowsearch; temp];
           elseif(sequence{1+1}.state == 1 && sequence{1+1}.action ==
2)
               temp = qvaluelowsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluehighwait(end)) -
qvaluelowsearch(end));
               qvaluelowsearch = [qvaluelowsearch; temp];
           elseif(sequence{1+1}.state == 2 && sequence{1+1}.action ==
1)
               temp = qvaluelowsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluelowsearch(end)) -
qvaluelowsearch(end));
               qvaluelowsearch = [qvaluelowsearch; temp];
           elseif(sequence{1+1}.state == 2 && sequence{1+1}.action ==
2)
               temp = qvaluelowsearch(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluelowwait(end)) -
qvaluelowsearch(end));
               qvaluelowsearch = [qvaluelowsearch; temp];
           elseif(sequence{1+1}.state == 2 && sequence{1+1}.action ==
3)
               temp = qvaluelowsearch(end) + stepsize *
(sequence{1}.reward + (0.8 * qvaluelowrecharge(end)) -
qvaluelowsearch(end));
               qvaluelowsearch = [qvaluelowsearch; temp];
           end
           qvaluelowwait = [qvaluelowwait; qvaluelowwait(end)];
           qvaluelowrecharge = [qvaluelowrecharge;
qvaluelowrecharge(end)];

       % Choosing to wait
       elseif(sequence{1}.action == 2)
           % Next step will be high, and two actions possible, search
           % and wait again
           if(sequence{1+1}.action == 1)
               temp = qvaluelowwait(end) + stepsize *
(sequence{1}.reward + (0.8 * qvaluelowsearch(end)) -
qvaluelowwait(end));
               qvaluelowwait = [qvaluelowwait; temp];
           else
               temp = qvaluelowwait(end) + stepsize
* (sequence{1}.reward + (0.8 * qvaluelowwait(end)) -
qvaluelowwait(end));
```

```
                qvaluelowwait = [qvaluelowwait; temp];
            end
            qvaluelowsearch = [qvaluelowsearch; qvaluelowsearch(end)];
            qvaluelowrecharge = [qvaluelowrecharge;
 qvaluelowrecharge(end)];

        % Choosing to recharge at low
        else
            if(sequence{1+1}.action == 1)
                temp = qvaluelowrecharge(end) + stepsize * ((0.8 *
 qvaluehighsearch(end)) - qvaluelowrecharge(end));
                qvaluelowrecharge = [qvaluelowrecharge; temp];
            elseif(sequence{1+1}.action == 2)
                temp = qvaluelowrecharge(end) + stepsize * ((0.8 *
 qvaluehighwait(end)) - qvaluelowrecharge(end));
                qvaluelowrecharge = [qvaluelowrecharge; temp];
            end
            qvaluelowsearch = [qvaluelowsearch; qvaluelowsearch(end)];
            qvaluelowwait = [qvaluelowwait; qvaluelowwait(end)];
        end

        qvaluehighsearch = [qvaluehighsearch; qvaluehighsearch(end)];
        qvaluehighwait = [qvaluehighwait; qvaluehighwait(end)];
    end
end
% celldisp(sequence);

t1=1:length(qvaluehighsearch);
t2=1:length(qvaluehighwait);
t3=1:length(qvaluelowsearch);
t4=1:length(qvaluelowwait);
t5=1:length(qvaluelowrecharge);

figure(1)
plot(t1, qvaluehighsearch, t2,qvaluehighwait);
xlabel('Episodes')
ylabel('State values')
legend({'search','wait'},'Location','southwest')
title('State High');

figure(2)
plot(t1, qvaluelowsearch, 1:length(qvaluelowwait), qvaluelowwait,
 1:length(qvaluelowrecharge), qvaluelowrecharge);
xlabel('Episodes')
ylabel('State values')
legend({'search','wait', 'recharge'},'Location','southwest')
title('State Low');
```


State High
State values
Episodes
search
wait
15
10
5
0
0
1000
2000
3000
4000
5000
6000


State Low
State values
Episodes
search
wait
recharge
12
10
8
6
4
2
0
-2
0
1000
2000
3000
4000
5000
6000

Published with MATLAB® R2021a