RS-HL-11: Multi User Simulation

UT Austin Oden Institute

Hongseok Kim

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I. Scope

In this report, the multi user simulation of satellite network control system is presented.

II. Algorithm

III. Code

III.1 Load the SAT-to-SAT dataset

```
clear;clc;
% Load the Satellite Contat Dataset
addpath('~/Desktop/Redstone_Project/RS_HL/RS_HL_10_TV_MDP_Functions')
load('/workspace/RS_Dataset/RS_HL_3_dataset.mat')
```

III.2 Run MDP

```
% Parameter Setting
time_index_vector = 100:120;
destination_state = 38;

% Run MDP
MDP = runMDP(sat_to_sat_contact_3d_matrix,
time_index_vector,destination_state);
```

```
simulation set up complete!
Policy: 1 -> Value Iteration: 485
Policy: 2 -> Value Iteration: 15
Policy: 3 -> Value Iteration: 5
Policy: 4 -> Value Iteration: 5
Policy: 5 -> Value Iteration: 8
Policy: 6 -> Value Iteration: 10
```

```
Policy: 7 -> Value Iteration: 9
Policy: 8 -> Value Iteration: 1
Policy: 9 -> Value Iteration: 1
Policy: 10 -> Value Iteration: 1
Policy: 11 -> Value Iteration: 1
```

III.3 User 1 Simulation

```
start_time = 100;
start_state = 3;

% Run Simulation
[time_list, reward_list, state_list, state_value_list]=
simulation_test(start_time,start_state,MDP,time_index_vector,destination_stat
e);

simultion_result = [time_list, state_list, reward_list, state_value_list]
```

```
simultion_result = 11×4
  100.0000    3.0000         0    2.0000
  101.0000    4.0000   -1.0000   10.5000
  102.0000    5.0000   -2.0000   19.0000
  103.0000   31.0000  -17.0000   41.5000
  104.0000   32.0000  -18.0000   50.0000
  105.0000   33.0000  -19.0000   58.5000
  106.0000   34.0000  -20.0000   67.0000
  107.0000   35.0000  -21.0000   75.5000
  108.0000   36.0000  -22.0000   84.0000
  109.0000   37.0000  -23.0000   92.5000
      ⋮
```

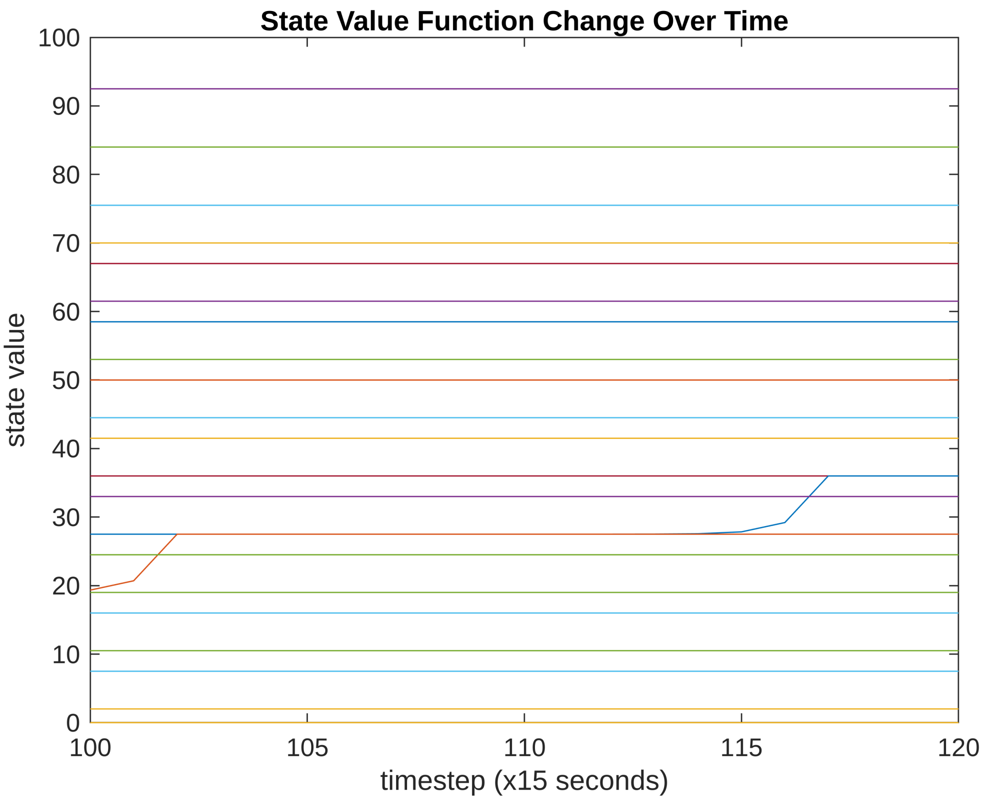
```
number_of_states = length(sat_to_sat_contact_3d_matrix(1,:,1));
state_value_over_time = zeros(length(time_index_vector),number_of_states);

for t = 1:length(time_index_vector)
    for state_index = 1:number_of_states
        state_value_over_time(t,state_index) = MDP.
(['time' num2str(time_index_vector(t))]).(['state' num2str(state_index)]).
('state_value');
    end
end

for state_index = 1:number_of_states
    plot(time_index_vector,state_value_over_time(:,state_index))
    hold on
end

hold off
```

```
title('State Value Function Change Over Time')
xlabel('timestep (x15 seconds)')
ylabel('state value')
```



III.4 Modification of sat-to-sat contact matrix from simulation 1

```
A = sat_to_sat_contact_3d_matrix;

for index = 1:length(time_list)-1

    time_index = time_list(index);
    state_index = state_list(index);

    A(state_index,:,time_index) = 0;
    A(:,state_index,time_index) = 0;
    A(state_index,state_index,time_index) = 1;

end

time_index_vector = 100:120;
destination_state = 38;
```

```
% Run MDP
MDP = runMDP(A, time_index_vector,destination_state);
```

```
simulation set up complete!
Policy: 1 -> Value Iteration: 485
Policy: 2 -> Value Iteration: 15
Policy: 3 -> Value Iteration: 5
Policy: 4 -> Value Iteration: 5
Policy: 5 -> Value Iteration: 8
Policy: 6 -> Value Iteration: 10
Policy: 7 -> Value Iteration: 9
Policy: 8 -> Value Iteration: 1
Policy: 9 -> Value Iteration: 1
Policy: 10 -> Value Iteration: 1
Policy: 11 -> Value Iteration: 1
```

III.Analysis

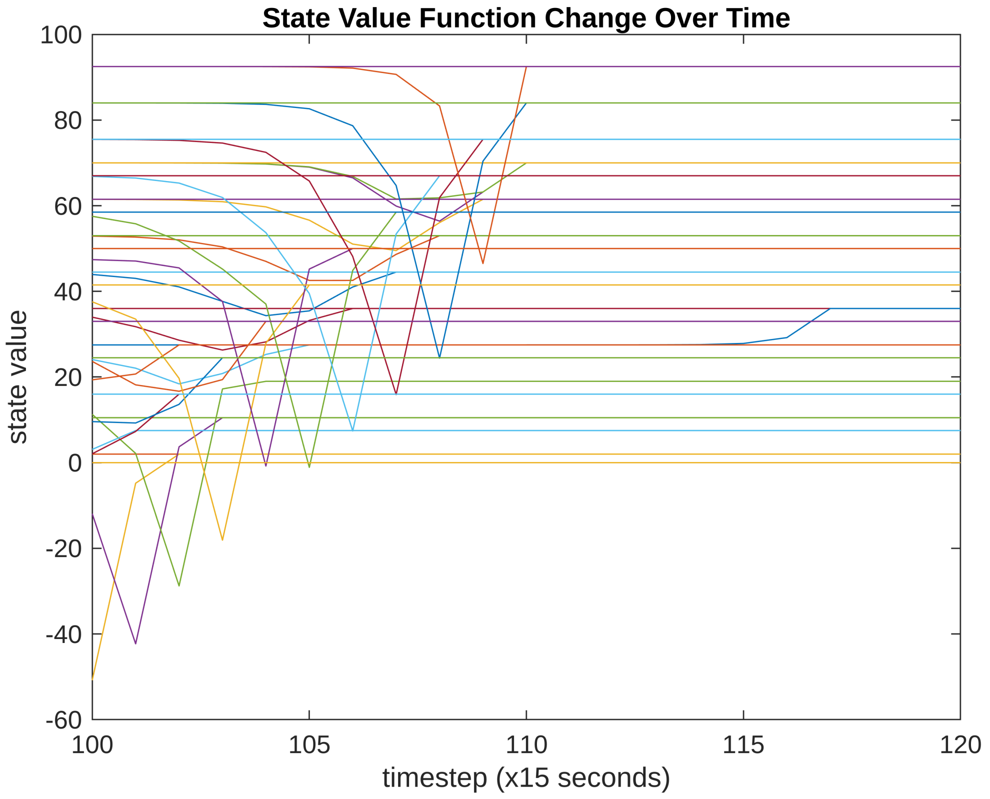
III.1 State Value changing over time

```
number_of_states = length(A(1,:,1));
state_value_over_time = zeros(length(time_index_vector),number_of_states);

for t = 1:length(time_index_vector)
    for state_index = 1:number_of_states
        state_value_over_time(t,state_index) = MDP.
(['time' num2str(time_index_vector(t))]).(['state' num2str(state_index)]).
('state_value');
    end
end

for state_index = 1:number_of_states
    plot(time_index_vector,state_value_over_time(:,state_index))
    hold on
end

hold off
title('State Value Function Change Over Time')
xlabel('timestep (x15 seconds)')
ylabel('state value')
```



```
start_time = 100;
start_state = 3;

% Run Simulation
[time_list, reward_list, state_list, state_value_list] =
simulation_test(start_time,start_state,MDP,time_index_vector,destination_stat
e);

simultion_result = [time_list, state_list, reward_list, state_value_list]
```

```
simultion_result = 13×4
  100.0000    3.0000         0  -50.8000
  101.0000    3.0000  -50.0000   -4.8000
  102.0000    2.0000  -51.0000    2.0000
  103.0000    1.0000  -52.0000   10.5000
  104.0000   46.0000  -67.0000   33.0000
  105.0000   45.0000  -68.0000   41.5000
  106.0000   44.0000  -69.0000   50.0000
  107.0000   43.0000  -70.0000   58.5000
  108.0000   42.0000  -71.0000   67.0000
  109.0000   41.0000  -72.0000   75.5000
     ⋮
```