MAS Course – Assignment 02 – Containment

Problem 03

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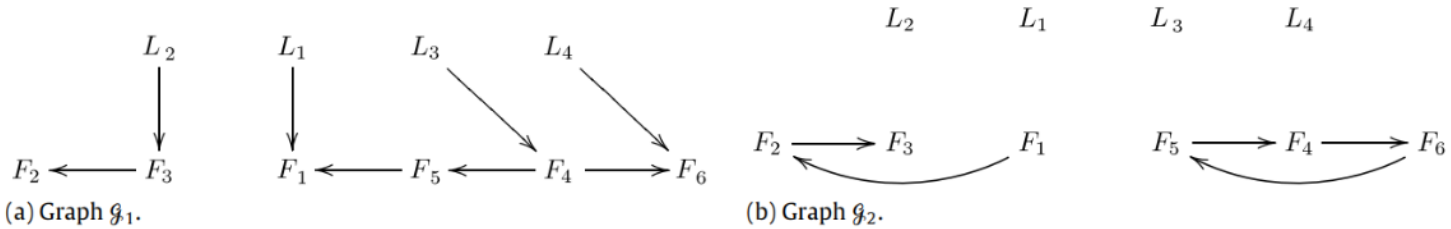
Study and analyze the collective behavior of a MAS under the following topologies and dynamics:



$$\dot{x}_i = u_i$$

$$u_i = 0 \qquad i \in \mathcal{V}_L$$

$$u_i = \sum_{j \in \mathcal{V}_F \cup \mathcal{V}_L} a_{ij}(t)\left(x_j - x_i\right) \qquad i \in \mathcal{V}_F$$

Define initial values to use in the code:

`numFollowers`

```
numFollowers = 6
```

`numLeaders`

```
numLeaders = 4
```

`numAgents`

```
numAgents = 10
```

Based on the given topologies, the Laplacian matrices of `L1` and `L2` are as follows:

`L1`

```
L1 = 10×10
     2     0     0     0    -1     0    -1     0     0     0
     0     1    -1     0     0     0     0     0     0     0
     0     0     1     0     0     0     0    -1     0     0
     0     0     0     1     0     0     0     0    -1     0
     0     0     0    -1     1     0     0     0     0     0
     0     0     0    -1     0     2     0     0     0    -1
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
```

`L2`

```
L2 = 10×10
     0     0     0     0     0     0     0     0     0     0
     0     1    -1     0     0     0     0     0     0     0
     0    -1     1     0     0     0     0     0     0     0
     0     0     0     1    -1     0     0     0     0     0
     0     0     0     0     1    -1     0     0     0     0
     0     0     0    -1     0     1     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0
```

Now lets set the `seed` value to avoid different random calues for each code run:

```
rng(2)
```

The timespan that the multi-agent system is going to be simulated:

```
tFinal
```

```
tFinal = 80
```

with the time step:

```
timeStep
```

```
timeStep = 0.1000
```

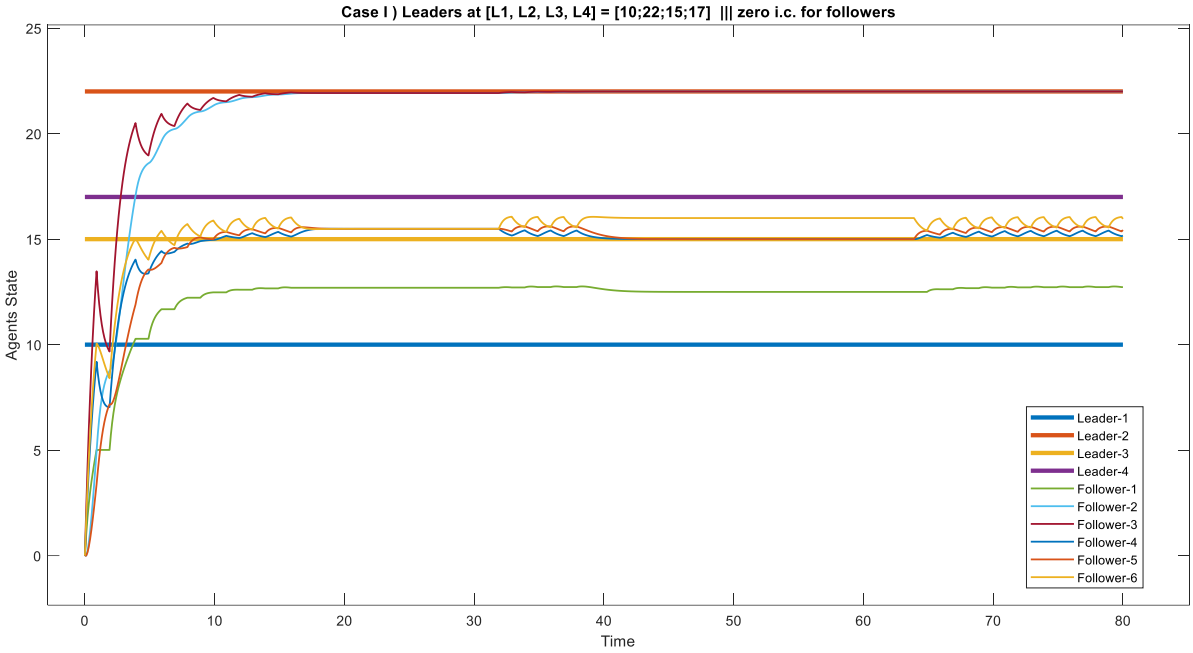
and the initial conditions for both leaders and followers as in

Case I) Leaders at [L1, L2, L3, L4] = [10;22;15;17] ||| zero i.c. for followers

```
x = [zeros(numFollowers,1)*5 ; 10;22;15;17]
```

```
x = 10×1
     0
     0
     0
     0
     0
     0
    10
    22
    15
    17
```

MAS responses are as follows:



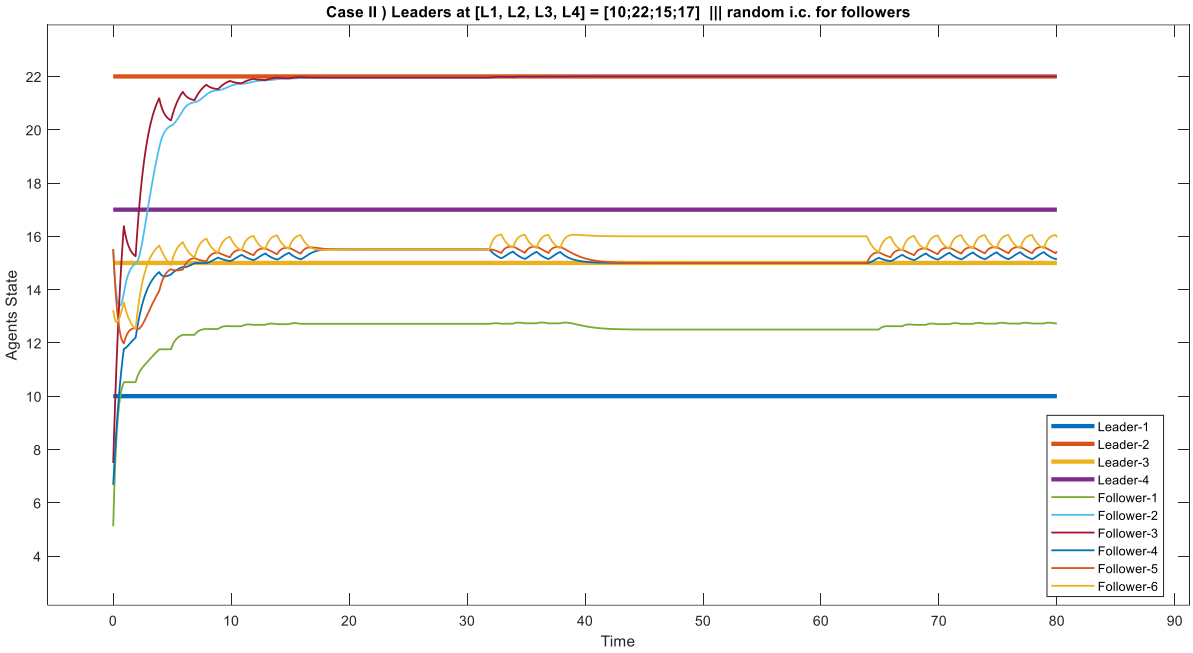
Thicker lines are the leaders' states which are constant by the way since their control signal are always zero, hence their state never changes. As expected, the follower agents have converged in to the convex hull of the four leaders i.e. all the follower lines are within the leader line boundaries.

Case II) Leaders at [L1, L2, L3, L4] = [10;22;15;17] ||| random i.c. for followers

```
x
```

```
x = 10×1
   10.8999
    0.6482
   13.7416
   10.8831
   10.5092
    8.2584
   10.0000
   22.0000
   15.0000
   17.0000
```

once again, the results are as follows:



This could be observed that the convergence behavior of the MAS is the same under different initial condition values.