ActuatorSelection_Test3_2

October 27, 2021

1 Benefit of Multiplicative (MPL) Models over Nominal (Nom) Models of Systems

Testing actuator selection and feedback of Nominal and MPL models on simulations of True system

Py Packages

[1]:
```
import numpy as np
from copy import deepcopy as dc
# %matplotlib widget

from functionfile_system_definition import sys_from_file, system_display_matrix
from functionfile_system_mplcost import simulation_nom_vs_mpl,␣
↪plot_simulation_nom_vs_mpl_1, plot_simulation_nom_vs_mpl_2,␣
↪actuator_comparison
```

1.1 Code

[2]:
```
test_set = 'System Model 4'
S_True = sys_from_file(test_set + ' True')
S_MPL = sys_from_file(test_set + ' MPL')
S_Nom = sys_from_file(test_set + ' Nominal')
```

```
System read from file @ system_model/System Model 4 True.pickle

System read from file @ system_model/System Model 4 MPL.pickle

System read from file @ system_model/System Model 4 Nominal.pickle
```

[3]:
```
ret_sim = simulation_nom_vs_mpl(S_Nom, S_MPL, S_True)
```

1.2 Output

System Models

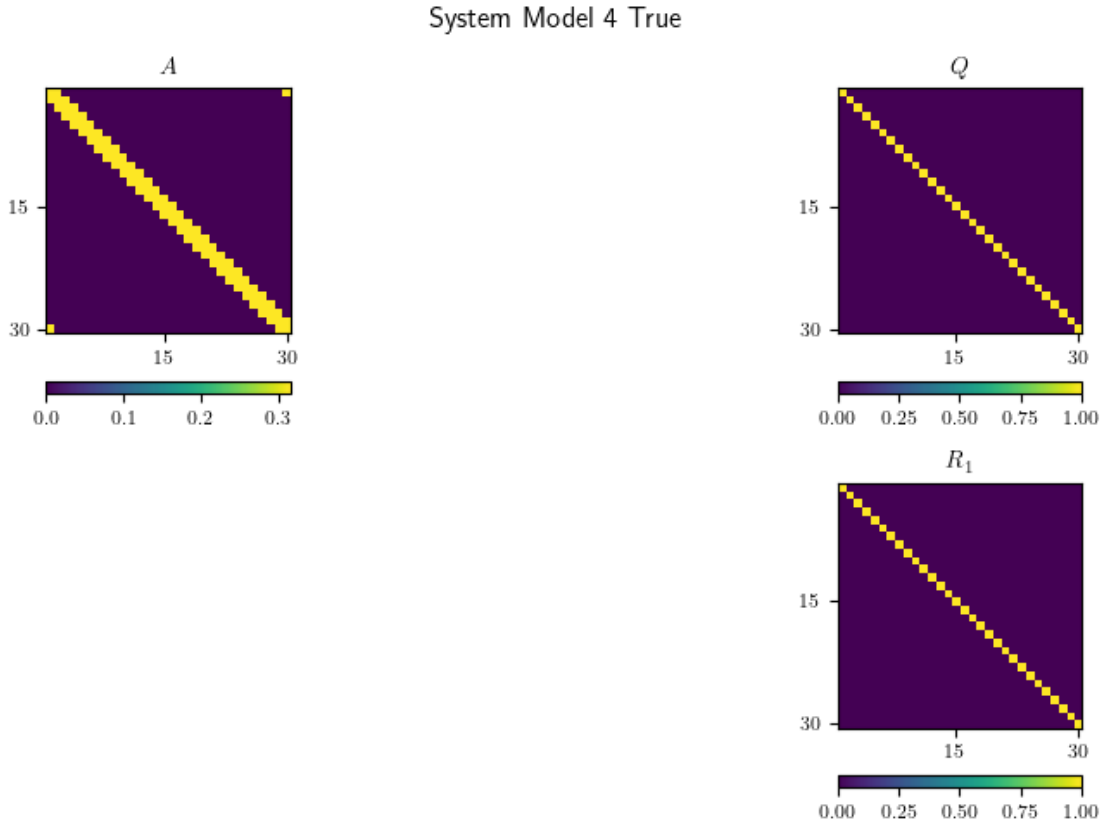
True System

[4]:
```

```

```
print('max(abs(eigvals(A)))= %.4f' % (np.max(np.abs(np.linalg.
 ↪eigvals(S_True['A'])))))
system_display_matrix(S_True)
```

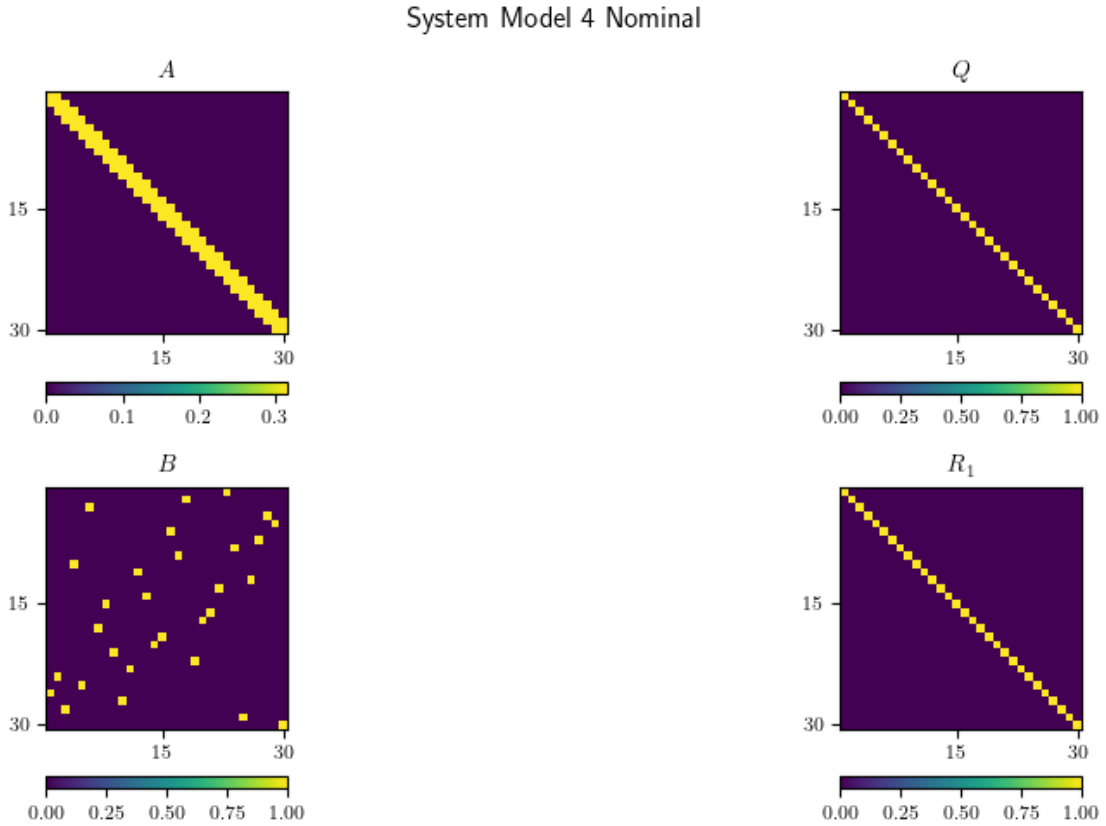
```
max(abs(eigvals(A)))= 0.9500
```



Nominal Model

[5]:
```
print('max(abs(eigvals(A)))= %.4f' % (np.max(np.abs(np.linalg.
 ↪eigvals(ret_sim['system_nom']['A'])))))
system_display_matrix(ret_sim['system_nom'])
```

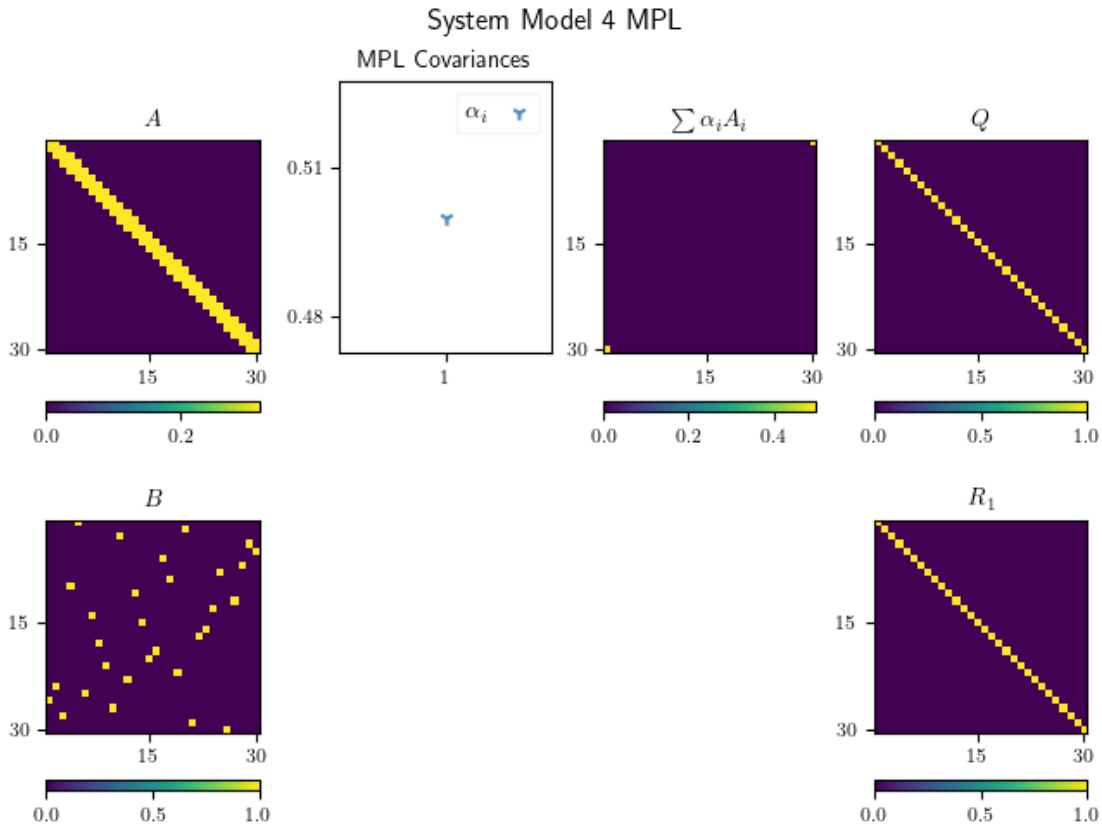
```
max(abs(eigvals(A)))= 0.9500
```



Multiplicative Noise Model

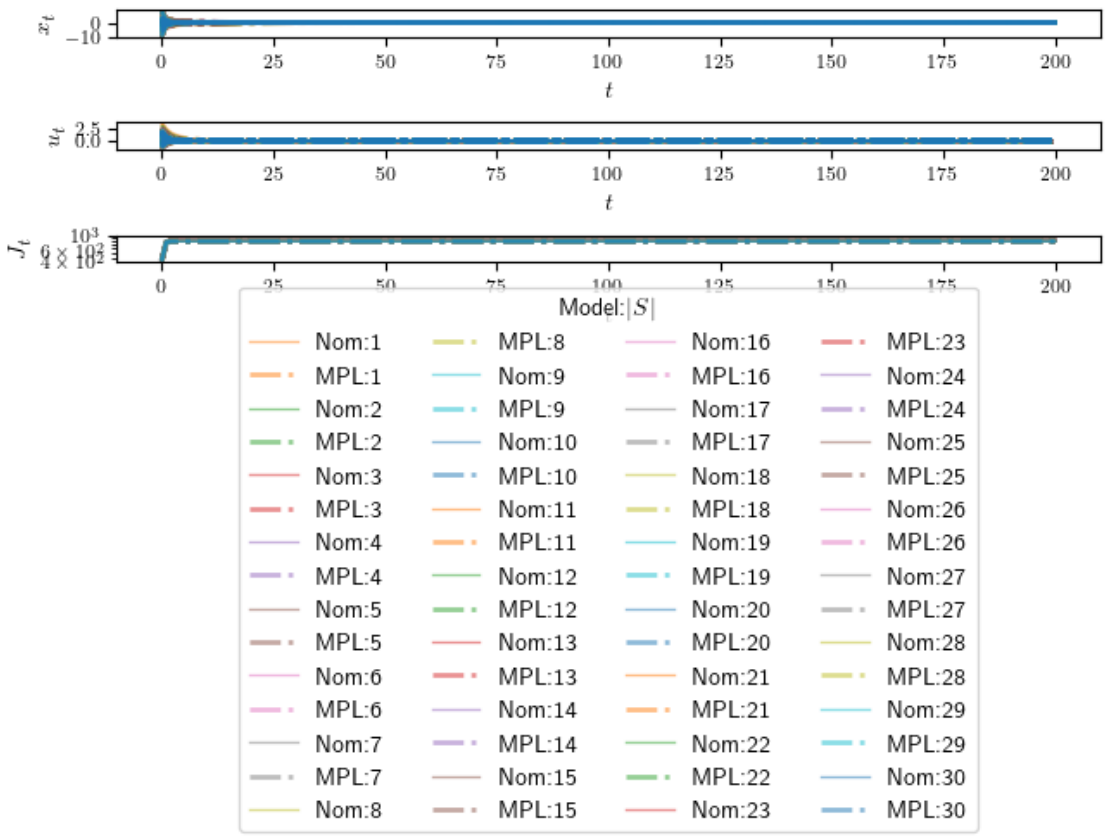
[6]:
```
print('max(abs(eigvals(A)))= %.4f' % (np.max(np.abs(np.linalg.
 ↪eigvals(ret_sim['system_mpl']['A'])))))
system_display_matrix(ret_sim['system_mpl'])
```

```
max(abs(eigvals(A)))= 0.9500
```



Simulation - Trajectory, Control Input and Costs

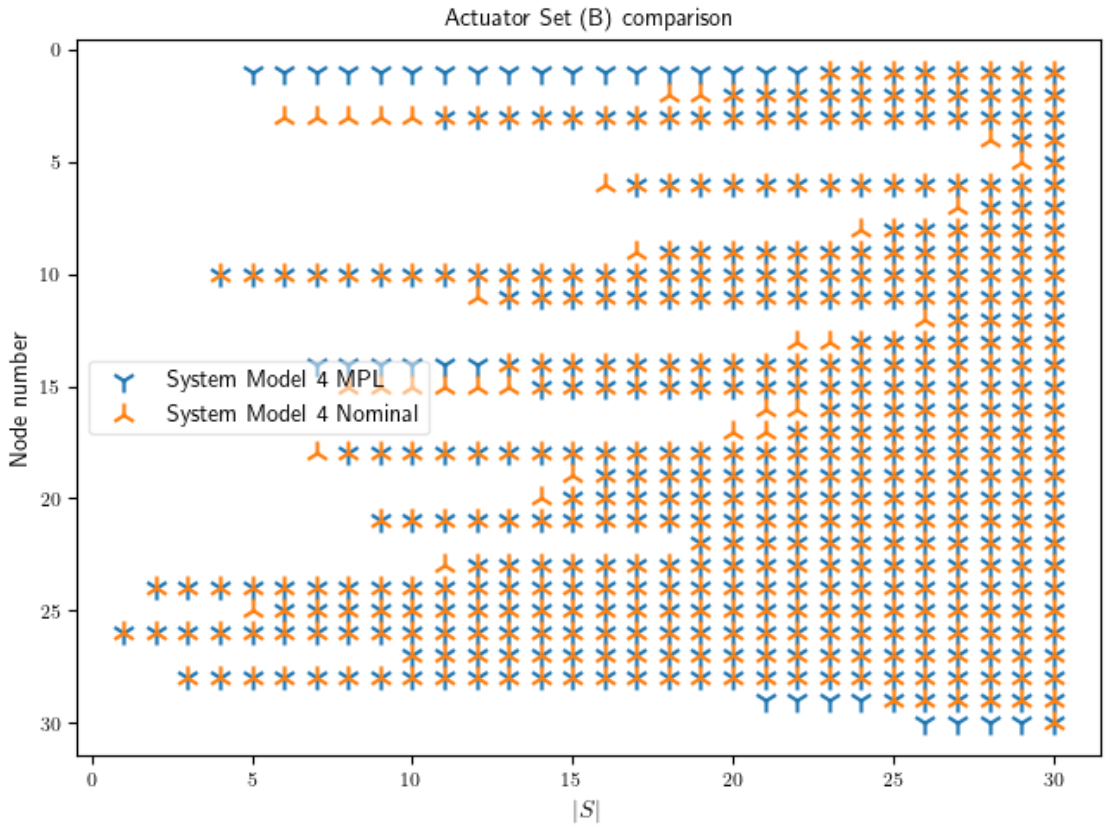
[7]:
```
plot_simulation_nom_vs_mpl_1(ret_sim)
```



Actuator set comparison

[8]:
```
actuator_comparison(ret_sim['system_mpl'], ret_sim['system_nom']);
```

```
Control sets are different
```



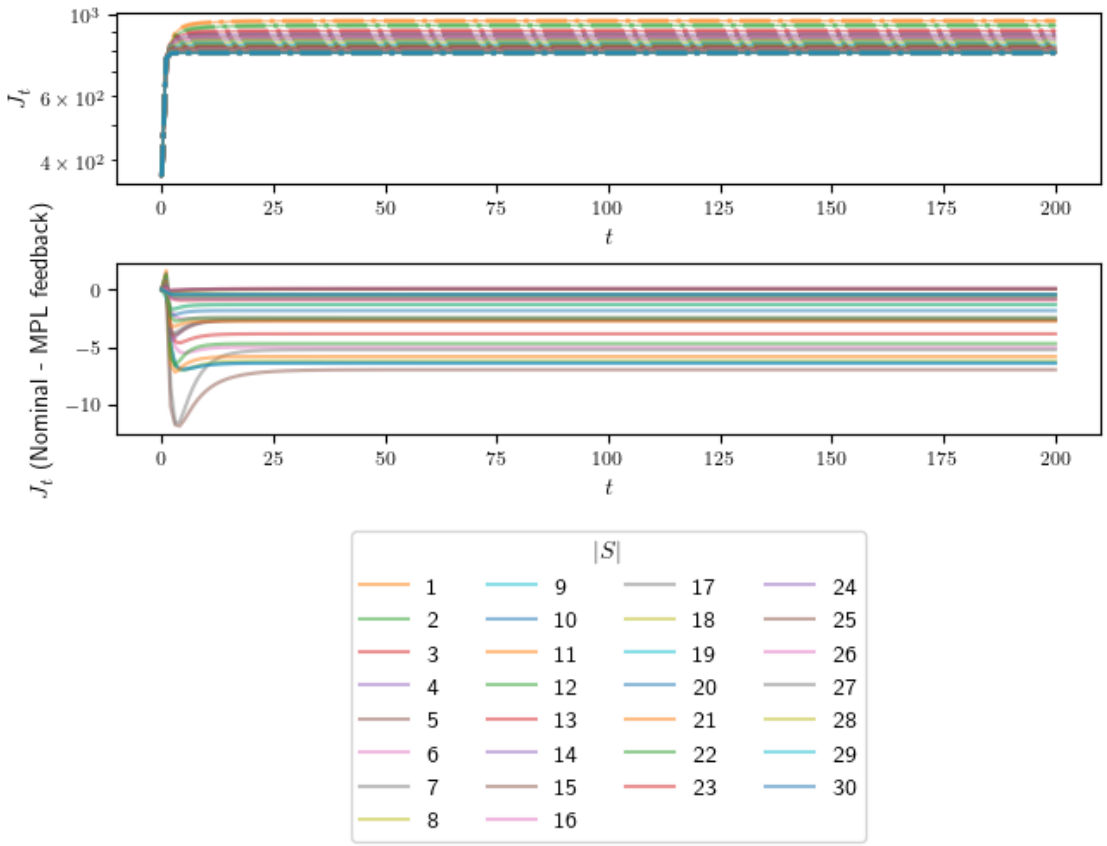
Simulated costs

[9]:
```
print('True simulation cost with <___> feedback (4decimal approx)')
for key in ret_sim['T_Nom']['costs']:
    print ("|S|: %s | Nom: %.4f | MPL: %.4f | Diff (Nom-MPL) %.4f" % (key,␣
 ↪ret_sim['T_Nom']['costs'][key][-1], ret_sim['T_MPL']['costs'][key][-1],␣
 ↪ret_sim['T_Nom']['costs'][key][-1]-ret_sim['T_MPL']['costs'][key][-1]))
#     print('|S|:', key, '| Nom:', ret_sim['T_Nom']['costs'][key][-1], '| MPL:
 ↪', ret_sim['T_MPL']['costs'][key][-1], ' | Diff (Nom-MPL):',␣
 ↪ret_sim['T_Nom']['costs'][key][-1]-ret_sim['T_MPL']['costs'][key][-1])
```

```
True simulation cost with <___> feedback (4decimal approx)
|S|: 1 | Nom: 962.9713 | MPL: 962.9457 | Diff (Nom-MPL) 0.0256
|S|: 2 | Nom: 935.1373 | MPL: 935.0968 | Diff (Nom-MPL) 0.0405
|S|: 3 | Nom: 902.6393 | MPL: 902.5681 | Diff (Nom-MPL) 0.0712
|S|: 4 | Nom: 883.5365 | MPL: 883.4699 | Diff (Nom-MPL) 0.0665
|S|: 5 | Nom: 871.6282 | MPL: 878.5864 | Diff (Nom-MPL) -6.9582
|S|: 6 | Nom: 861.6370 | MPL: 866.6495 | Diff (Nom-MPL) -5.0124
|S|: 7 | Nom: 851.8323 | MPL: 857.0685 | Diff (Nom-MPL) -5.2362
|S|: 8 | Nom: 838.6069 | MPL: 844.8019 | Diff (Nom-MPL) -6.1950
|S|: 9 | Nom: 827.1451 | MPL: 833.5324 | Diff (Nom-MPL) -6.3873
|S|: 10 | Nom: 820.2233 | MPL: 826.6019 | Diff (Nom-MPL) -6.3786
```

```
|S|: 11 | Nom: 815.2564 | MPL: 821.0722 | Diff (Nom-MPL) -5.8158
|S|: 12 | Nom: 811.4099 | MPL: 816.1096 | Diff (Nom-MPL) -4.6996
|S|: 13 | Nom: 807.6807 | MPL: 811.5322 | Diff (Nom-MPL) -3.8515
|S|: 14 | Nom: 804.4622 | MPL: 807.0688 | Diff (Nom-MPL) -2.6066
|S|: 15 | Nom: 801.1757 | MPL: 803.8503 | Diff (Nom-MPL) -2.6746
|S|: 16 | Nom: 798.0878 | MPL: 800.5637 | Diff (Nom-MPL) -2.4759
|S|: 17 | Nom: 794.9619 | MPL: 797.6408 | Diff (Nom-MPL) -2.6789
|S|: 18 | Nom: 793.2002 | MPL: 794.5208 | Diff (Nom-MPL) -1.3206
|S|: 19 | Nom: 791.4915 | MPL: 792.8121 | Diff (Nom-MPL) -1.3206
|S|: 20 | Nom: 790.1782 | MPL: 792.0134 | Diff (Nom-MPL) -1.8353
|S|: 21 | Nom: 788.6895 | MPL: 791.4238 | Diff (Nom-MPL) -2.7343
|S|: 22 | Nom: 787.6521 | MPL: 790.1105 | Diff (Nom-MPL) -2.4584
|S|: 23 | Nom: 787.7195 | MPL: 788.6219 | Diff (Nom-MPL) -0.9024
|S|: 24 | Nom: 787.0284 | MPL: 787.5844 | Diff (Nom-MPL) -0.5560
|S|: 25 | Nom: 786.4234 | MPL: 786.8932 | Diff (Nom-MPL) -0.4698
|S|: 26 | Nom: 786.0438 | MPL: 786.8613 | Diff (Nom-MPL) -0.8175
|S|: 27 | Nom: 785.7083 | MPL: 786.4818 | Diff (Nom-MPL) -0.7735
|S|: 28 | Nom: 785.6232 | MPL: 786.1463 | Diff (Nom-MPL) -0.5231
|S|: 29 | Nom: 785.6020 | MPL: 786.0604 | Diff (Nom-MPL) -0.4584
|S|: 30 | Nom: 785.5967 | MPL: 786.0393 | Diff (Nom-MPL) -0.4426
```

[10]:
```
plot_simulation_nom_vs_mpl_2(ret_sim)
```



1.3 Run Complete

[11]:
```
print('Run Complete')
```

```
Run Complete
```