Contents

1 TS-Toolbox: LiP MISO example (Ladedruck)

```
% $Id: NARX_MISO_Ladedruck.m | Fri Feb 26 16:22:06 2021 +0100 | Axel Dürrbaum  $

clear
close all

addpath( '../TSModel' ) % Path to TSModel files
```

2 Modell order

```
nc = 3;    % number of clusters = local models
% Selection of inputs in data
inu = [1,2,3,4,5]
%inu = 1:5;
nu = length(inu);    % number of inputs
nue = 1.2; % fuziness parameter

% Input vector u and output vector y
load( 'Data/MISO_Ladedruck.mat' )
dt = 1; % Implicit sampling time for static models
```

```
inu =
     1     2     3     4     5
```

3 Create TS model

```
ts = TSModel( 'ARX', nc, nu, 'Name','Ladedruck',...
'Comment','IAV Überlandfahrt 24.3.2013 Konstante Einspritzcharakteristik');
ts.setFuzziness( nue );
ts.set_msf_type( 'FCM' );
ts.setSchedulingLags( {0,0,0,0,0}, [1,2,3] );
ts.setRegressorLags( {0,0,0,0,0}, [1,2,3] );
```

4 I/O data

```
Labels = {};
u = [];
for i=inu
    Labels{end+1} = data.u(i).label;
    u = [u,data.u(i).Vals];
end
Labels{end+1} = data.y.label;
y = data.y.Vals;
dt = data.y.ts;
ts.setData( u, y, 'SampleTime',dt, 'Labels', Labels,  ...
    'Comment', 'from dataset' );
%ts.setDataLimits( [0,2 ;0,2; -7,7] );
```

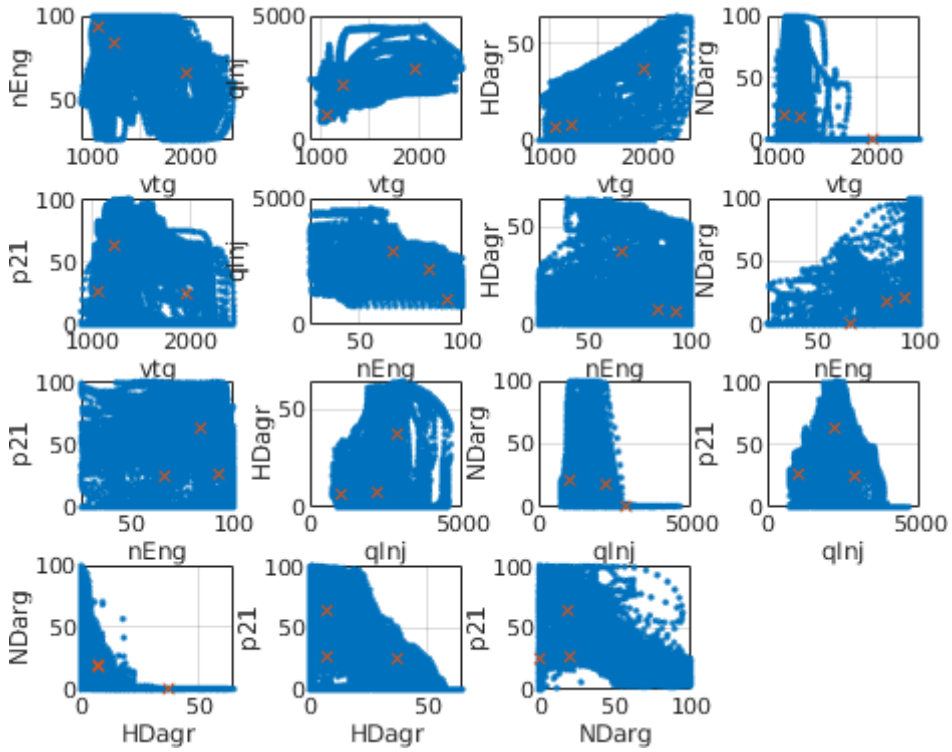
5 Clustering in product-space (u,y)

```
ts.clustering( 'FCM', 'nue', nue, 'tries',2, 'seed', 0 )
c1 = getCluster(ts);
```

```
ans =
TS-Model: Type=ARX
Name: 'Ladedruck'
 Type: 'TSModel'
 Date: '29-Mar-2021 15:10:33'
 Comments:
  'IAV Überlandfahrt 24.3.2013 Konstante Einspritzcharakteristik'
 Structural parameters: nu = 5, ny = 1, nv = 3
 Identification data: N=92207
, ts=0.01 (from dataset) Initial model estimation:
 lags: u_1:0, u_2:0, u_3:0, u_4:0, u_5:0, y = [1 2 3]
  Membership function type = FCM
  Clustering: FCM, nue=1.2 norm=Euclidian in input space
 Estimation of local models:
 lags:    u_1:0,   u_2:0,   u_3:0,   u_4:0,   u_5:0,   y = [1 2 3]
```

6 Plot co Clustering

```
figure(1),clf
x = [y,u];
c = c1(:,[1,4:end]);
[sr,sc] = getSubplotPar( nu + 1 );
s=0;
for i1=1:nu
    for i2=i1+1:nu+1
        s=s+1;
        subplot(sr,sc,s)
        plot(x(:,i1),x(:,i2),'.')
        grid on
        xlabel( ts.Labels(i1) )
        ylabel( ts.Labels(i2) )
        hold on
        plot(c(:,i1),c(:,i2),'x')
        hold off
    end
end
orient landscape
print('-dpdf','-bestfit','Test_SISO_Ladedruck_clustering.pdf')
```

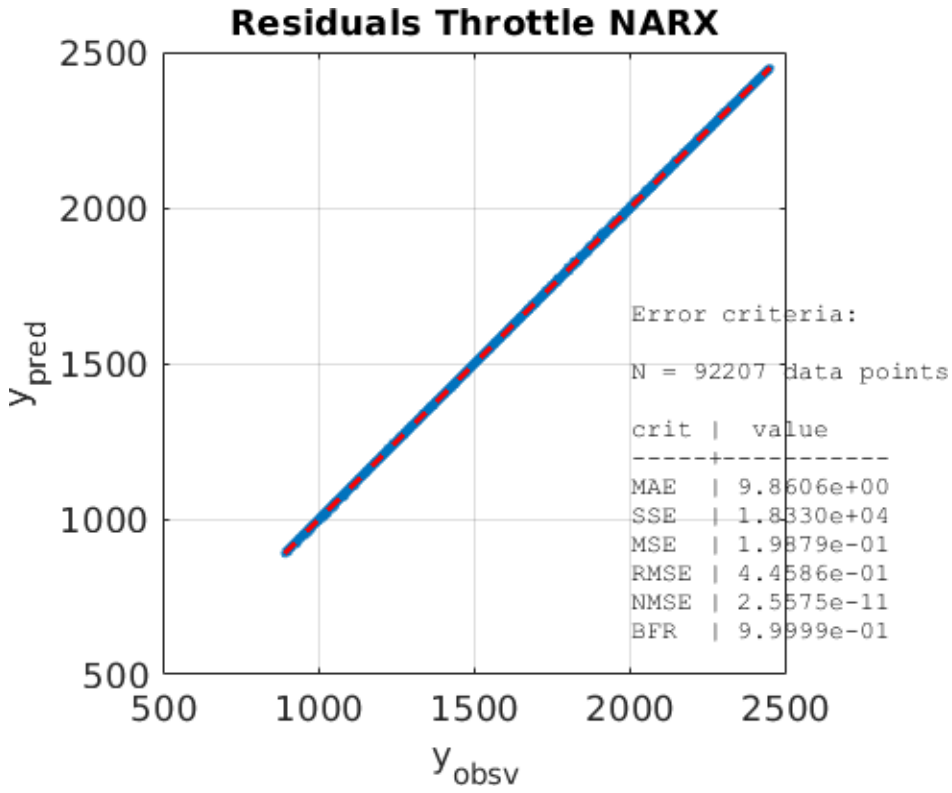


7 Initial modell

```
ts.initialize( 'FCM', 'nue', nue, 'method','global'  );
```

8 Evaluation of initial modell

```
yp = ts.predict( u,y );
plotResiduals( y, yp, 'figure', 2, 'title', 'Residuals Throttle NARX' );
orient landscape
print('-dpdf','-bestfit','Test_SISO_Ladedruck.pdf')
```



9 Optimize Clusters c (MF) and/or local model A/B/C

```
ts.optimize( 'B' )
c2 = getCluster( ts );
ypo = ts.predict( u,y );
plotResiduals( y, ypo, 'figure', 3, 'title', 'Residuals MISO Ladedruck NARX opt' );

orient landscape
print('-dpdf','-bestfit','Test_SISO_Ladedruck_opt.pdf')
```

Iteration	Func-count	f(x)	Norm of step	First-order optimality
0	52	315687		5.62e+07
1	104	233167	10	6.71e+06
2	156	191464	20	2.21e+07
3	208	155323	40	2.07e+06
4	260	105797	80	8.47e+06
5	312	41858.9	160	1.38e+06
6	364	18978.7	186.632	9.18e+06
7	416	16742.5	54.7038	2.36e+05
8	468	16742.5	260.082	2.36e+05
9	520	16706.9	65.0205	1.9e+05
10	572	16691	65.0205	4.77e+05
11	624	16673	16.2551	8.84e+04
12	676	16651.1	32.5103	1.22e+05
13	728	16629.2	32.5103	9.1e+04
14	780	16606.6	32.5103	9.25e+04
15	832	16583.9	32.5103	9.52e+04
16	884	16562	32.5103	9.55e+04
17	936	16539.7	32.5103	9.78e+04
18	988	16518.3	32.5103	9.93e+04
19	1040	16497.4	32.5103	1.01e+05
20	1092	16470.2	65.0205	1.1e+05
21	1144	16424	65.0205	2.63e+05
22	1196	16389.8	130.041	1.08e+06
23	1248	16389.8	260.082	1.08e+06
24	1300	16336.7	65.0205	6.36e+04
25	1352	16314.4	130.041	1.22e+05
26	1404	16293.3	260.082	5.7e+05
27	1456	16265.6	260.082	1.94e+05
28	1508	16236.9	520.164	4.9e+05
29	1560	16210.7	520.164	4.93e+05
30	1612	16185.8	573.651	4.66e+05
31	1664	16185.8	358.186	4.66e+05
32	1716	16174.3	89.5465	1.92e+05

```
Local minimum possible.

lsqnonlin stopped because the final change in the sum of squares relative to
its initial value is less than the value of the function tolerance.

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Estimation of local models:
lags:    u_1:0,    u_2:0,    u_3:0,    u_4:0,    u_5:0,    y = [1 2 3]
 Initialization of local models: global
 Optimization of model parameters: MF&LM
```