Structure and parameter identification of au

October 4, 2019

1 Experimental data

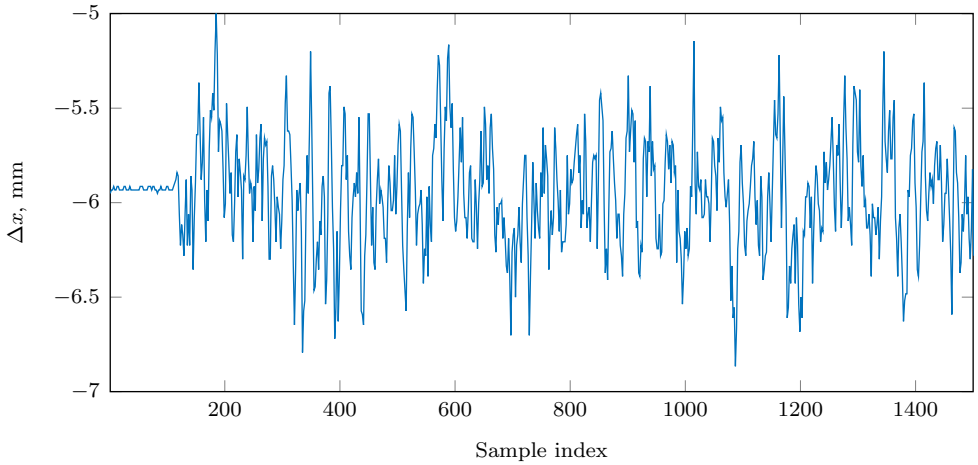


Figure 1: The input for the set C.

2 Structure identification

The following model structure is assumed. The output of the NARX model $\boldsymbol{y}(t)$ is the measured load. The input vector is composed as

$$\boldsymbol{x}(t) = \{x_i(t)\}_{i=1}^{d} = \left[\{y(t-k+1)\}_{k=1}^{n_y} \quad \{u(t-k+n_y+1)\}_{k=n_y+1}^{n_y+n_u}\right]^\top, \tag{1}$$

where n_u is the length of the input lag and n_y is the length of the output lag in discrete time, and where $d = n_u + n_y$. In this case, the identification is performed under the following assumptions:

- only the input signal affects the output ($n_y = 0$).
- the input signal has a lag of length $n_u = 4$.

The unknown model is approximated with a sum of polynomial basis functions up to second degree ($\lambda = 2$), rendering the following structure

$$\boldsymbol{y}(t) = \theta^0 + \sum_{i=1}^{d} \theta_i x_i(t) + \sum_{i=1}^{d}\sum_{j=1}^{d} \theta_{i,j} x_i(t) x_j(t) + e(t). \tag{2}$$

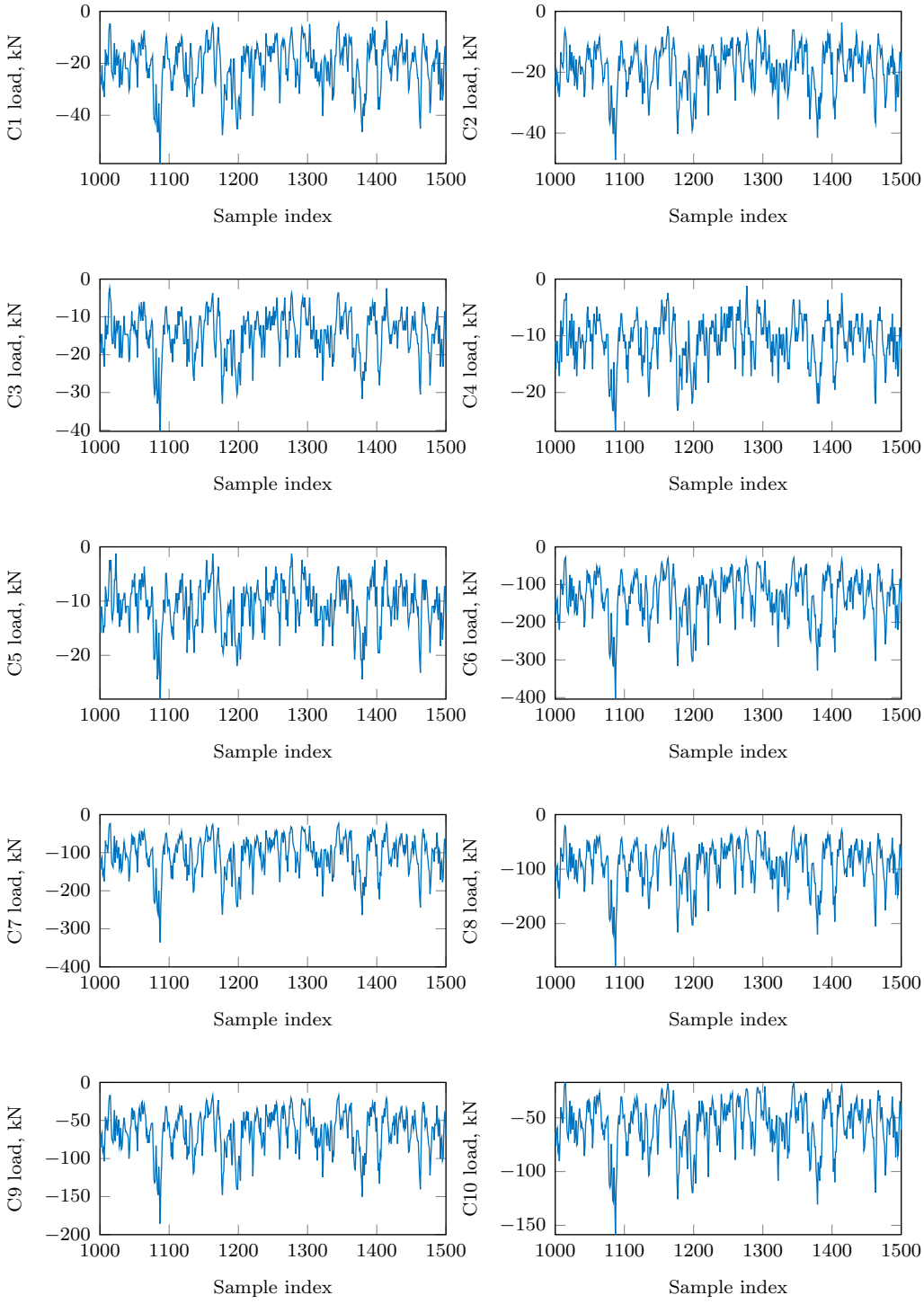
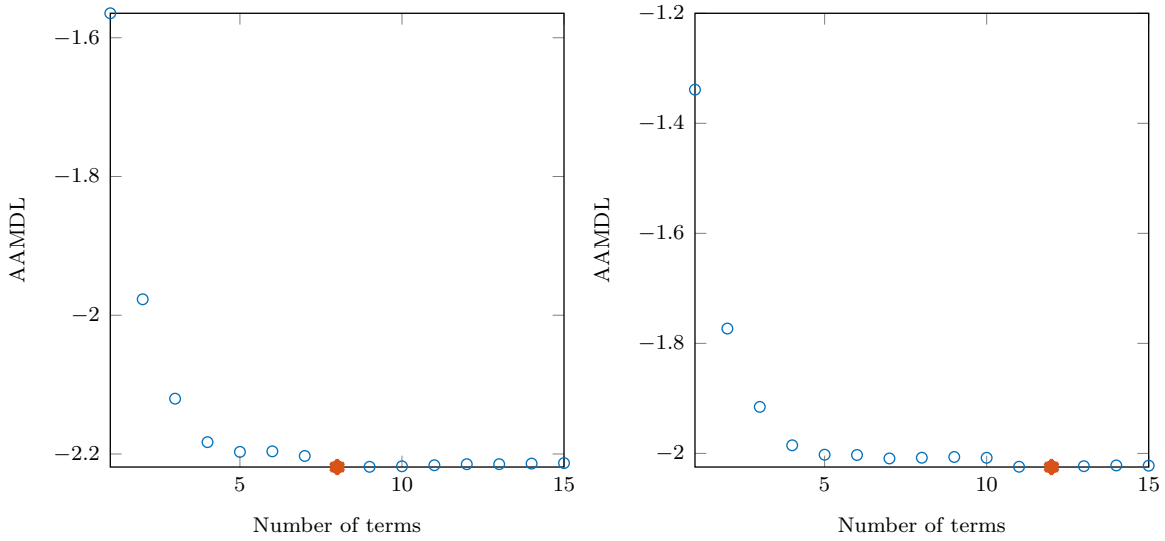


Figure 2: Experimental data.

The number and order of significant terms are identified within the EFOR-CMSS algorithm based on the data from 8 out of 10 datasets. Figure 3 illustrates the relationship between the number of model terms and the selected criterion of significance, AAMDL.



(a) Sample size 2000.

(b) Sample size 4000.

Figure 3: AAMDL evolution with the growing number of terms for samples of different size.

3 Parameter estimation

Table 1: Estimated parameters for the sample length 2000.

Step	Terms	C1	C2	C4	C5	C6	C7	C9	C10	AEER	AAMDL
1	c	-234.54	-204.62	-69.32	-119.47	-1570.61	-1369.94	-810.16	-578.87	0	-1.565
2	x_4	-177.03	-144.09	-68.52	-76.68	-1355.31	-1111.81	-630.59	-490.28	0	-1.977
3	x_3	84.08	64.3	40.2	28.83	725.98	566.33	311.64	259.45	0	-2.12
4	x_4, x_4	-23.32	-17.55	-8.58	-11.12	-150.42	-144.42	-83.78	-56.07	0	-2.183
5	x_3, x_4	9.41	4.86	2.53	5.82	19.58	58.54	37.45	9.85	0	-2.197
6	x_3, x_3	3.85	4.19	2.53	0.2	63.86	28.86	13.13	21.49	0	-2.196
7	x_2	1.42	0.75	-2.7	-0.05	43.65	38.66	17.66	13.68	0	-2.203
8	x_1	-4.32	-2.9	0.19	-0.79	-54.57	-45.03	-21.76	-17.7	0	-2.219

Table 2: Estimated parameters for the sample length 4000.

Step	Terms	C1	C2	C4	C5	C6	C7	C9	C10	AEER	AAMDL
1	c	-165.57	-140.83	-57.88	-93.13	-1037.61	-964.13	-559.51	-370.04	0	-1.339
2	x_4	-156.14	-123.14	-60.44	-67.23	-1089.72	-931.89	-530.57	-398.02	0	-1.773
3	x_3	77.52	56.15	33.75	22.39	466.78	421.82	244.52	171.74	0	-1.915
4	x_4, x_4	-19.62	-12.42	-4.16	-7.3	-103.98	-95.74	-55.36	-35.81	0	-1.985
5	x_3, x_4	-0.61	-10.91	-11.57	-7.03	-126.87	-80.74	-39.74	-50.79	0	-2.002
6	x_3, x_3	16.49	22.71	13.74	12.56	259.29	184.73	99.4	95.7	0	-2.003
7	x_2	-19.39	-14.83	-13.43	-5.4	-54.34	-71.89	-35.85	-9.18	0	-2.009
8	x_2, x_4	1.31	5.3	4.35	5.21	55.56	39.19	20.47	21.91	0	-2.008
9	x_2, x_3	-16.39	-22.92	-9.28	-13.26	-288.73	-197.82	-106.81	-103.02	0	-2.007
10	x_2, x_2	5.77	7.59	1.49	3.72	108.29	70.29	38.62	38.72	0	-2.008
11	x_1	25.77	21.68	13.42	10.92	220.93	169.96	85.56	72.68	0	-2.024
12	x_1, x_4	5.03	4.03	2.28	1.83	45.48	35.21	17.78	14.85	0	-2.025