ID6

ARMAX Identification

6.21 EXAMPLE 6.7

This example refers to the gas power plant of Pont–sur–Sambre already considered in ID3.21. As a first step, an high order ARX model with order $n = 36$ and structure $\nu = (12, 12, 12)$ has been identified and the standard deviation of its residuals used to scale the data; the first output has been divided by 16.3771, the second by 4.3766 and the third by 3.8886. Models with structures increasing from $\nu = (2, 2, 2)$ to $\nu = (7, 7, 7)$ have then been identified. Table 6.1 reports the corresponding standard deviations of the innovations of the associated predictors and the values assumed by loss function (6.20.4).

These results show the modest effect of variations in the order of the model from $n = 6$ to $n = 21$. Considering then models with order 9 as a reasonable compromise between accuracy and complexity, the structures (3,3,3), (4,2,3), (4,3,2), (2,4,3), (3,4,2), (2,3,4) and (3,2,4) have been compared. The results reported in Table 6.2 show how these variations in the model structure influence the standard deviations of the corresponding predictors. The values reported in Tables 6.1 and 6.2 must be compared with the standard deviations of the outputs given, after scaling, by $\sigma_{y_1} = 29.18$, $\sigma_{y_2} = 39.57$ and $\sigma_{y_3} = 55.23$.

ν	σ_{e_1}	σ_{e_2}	σ_{e_3}	$V(\theta)$	$PPCRE$
(2,2,2)	1.36	1.31	1.29	5.23	3.09%
(3,2,2)	1.21	1.20	1.27	4.52	2.88%
(3,3,2)	1.19	1.17	1.29	4.45	2.85%
(3,3,3)	1.18	1.16	1.24	4.28	2.80%
(4,3,3)	1.19	1.16	1.22	4.25	2.79%
(4,4,3)	1.17	1.15	1.22	4.18	2.77%
(4,4,4)	1.17	1.14	1.22	4.16	2.76%
(5,4,4)	1.12	1.15	1.21	4.04	2.72%
(5,5,4)	1.08	1.12	1.22	3.91	2.67%
(5,5,5)	1.09	1.13	1.20	3.91	2.67%
(6,5,5)	1.09	1.10	1.16	3.74	2.62%
(6,6,5)	1.06	1.09	1.19	3.73	2.61%
(6,6,6)	1.06	1.08	1.14	3.59	2.56%
(7,6,6)	1.07	1.06	1.14	3.57	2.56%
(7,7,6)	1.07	1.07	1.16	3.64	2.58%
(7,7,7)	1.05	1.06	1.07	3.37	2.48%

Table 6.1 – Performance of 16 different models

ν	σ_{e_1}	σ_{e_2}	σ_{e_3}	$V(\theta)$	$PPCRE$
(3,3,3)	1.18	1.16	1.24	4.28	2.80%
(4,2,3)	1.18	1.19	1.24	4.52	2.88%
(4,3,2)	1.20	1.18	1.27	4.45	2.85%
(2,3,4)	1.38	1.23	1.26	4.28	2.80%
(3,2,4)	1.18	1.20	1.23	4.25	2.79%
(2,4,3)	1.45	1.36	1.27	4.18	2.77%
(3,4,2)	1.20	1.19	1.24	4.16	2.76%

Table 6.2 – Performance of order 9 models with different structures

An even more effective picture of the performance of the whole family of the models described in Tables 6.1 and 6.2 (covering 16 different orders and 22 structures) can be observed in Figures 6.21, 6.22 and 6.23 where the actual outputs (continuous lines) are compared with the *worst* predictions (dotted lines) over the whole family of models: the curves are almost undistinguishable. Figures 6.21, 6.22 and 6.23 report also, in the same scale but translated, the innovations of the worst predictor.

It can be of some interest also to evaluate how previous models fulfill the assumption of independence between the components of $w(t)$ leading to loss function (6.20.4). In general, even if some improvement can be observed on higher order models, a non negligible dependence can be observed.

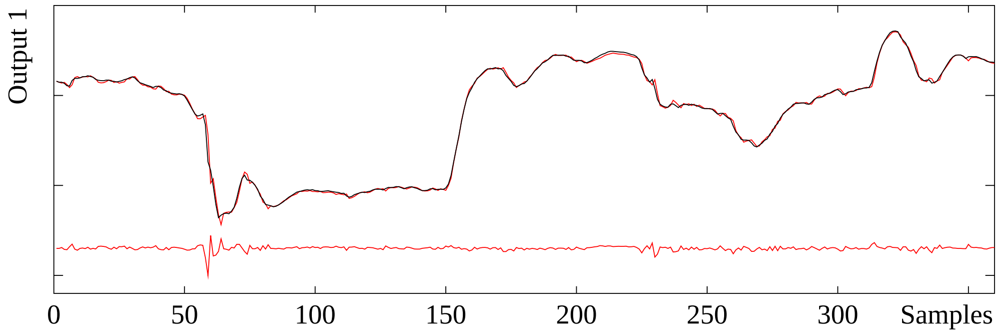

Figure 6.21 – Output 1, its worst prediction and associated innovations (red lines)

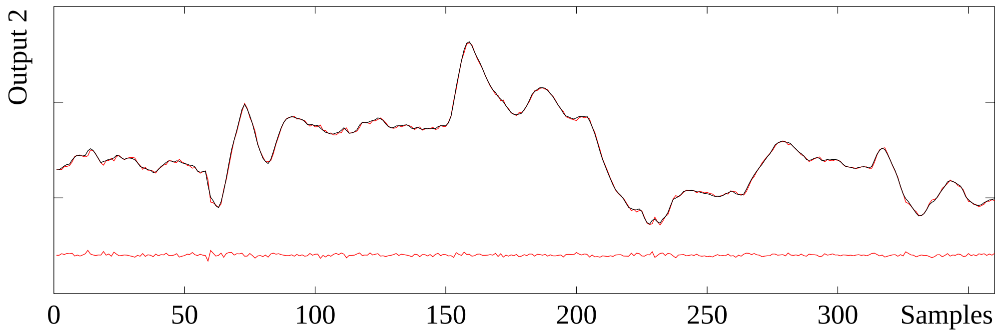

Figure 6.22 – Output 2, its worst prediction and associated innovations (red lines)

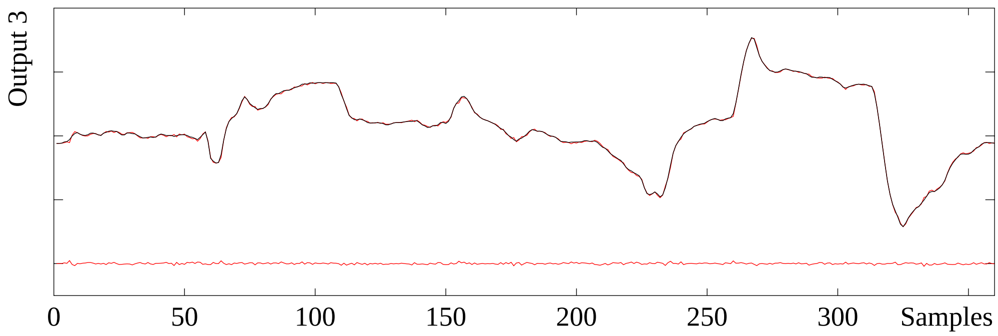

Figure 6.23 – Output 3, its worst prediction and associated innovations (red lines)