ID8

ARIMA(X) Identification

8.1 ARIMA(X) MODELS

The data observed on real processes contain often information on both the dynamical behavior of the system to be modeled and on other slower phenomena linked to different causes like seasonal variations, low frequency disturbances, offsets. In all these situations a direct identification with AR(X) or ARMA(X) models could lead to unsatisfactory results; different strategies can be developed whether the inclusion of these behaviors in the model is of interest or not. In the last case it is possible to perform a preliminary filtering of the data to remove all disturbances. It is usual, for instance, in econometrics, to introduce seasonal compensations or to balance the variations due to inflation. On the contrary, if we are also interested in inserting in the model also a description of these disturbances, we can try to modify accordingly the stochastic part of the model including, for instance, an integration. Thus ARIMAX (I for Integration) models differ from ARMAX ones in the description of the equation error term, which is of the type

$$e(t) = \frac{w(t) + \gamma_1 w(t-1) + \ldots + \gamma_n w(t-n)}{1 - z^{-1}} = \frac{r(z^{-1})}{1 - z^{-1}}\, w(t)\,; \tag{8.1.1}$$

the whole model has the following structure

$$q(z^{-1})\, y(t) = p(z^{-1})\, u(t) + \frac{r(z^{-1})}{1 - z^{-1}}\, w(t). \tag{8.1.2}$$

It can be immediately verified, by introducing the notations

$$y^d(t) = \left(1 - z^{-1}\right) y(t) = y(t) - y(t-1) \tag{8.1.3}$$

$$u^d(t) = \left(1 - z^{-1}\right) u(t) = u(t) - u(t-1) \tag{8.1.4}$$

for one–step output and input variations, that the model (8.1.2) can be rewritten in the ARMAX form

$$q(z^{-1})\, y^d(t) = p(z^{-1})\, u^d(t) + r(z^{-1})\, w(t). \tag{8.1.5}$$

Any ARIMAX model can thus be considered as an ARMAX model linking difference sequences (8.1.3) and (8.1.4) instead than observed input and output samples; it can thus be identified with the procedures already described for ARMAX models. Similar considerations can be repeated for ARIMA models

$$q(z^{-1})\, y(t) = \frac{r(z^{-1})}{1 - z^{-1}}\, w(t) \tag{8.1.6}$$

equivalent to ARMA models

$$q(z^{-1})\, y^d(t) = r(z^{-1})\, w(t). \tag{8.1.7}$$

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