Errata to (2000 printing)
Adaptive filtering and change detection

This is a list of the essential errors in the first printing, 2000. These are corrected in the 2001 printing.

Page 9 Equation (1.2) should be \( \hat{\theta}_t = \hat{\theta}_{t-1} + (1 - \lambda_t) \varepsilon_t \) to be consistent with e.g. (3.12).

Pages 60-61 Sections 3.3.1-3.3.2 use incorrect scalings of variances \( P_t \). These should be

\[
\begin{align*}
P_t &= \frac{1}{t^2} \sum_{i=1}^{t} R = R/t, \\
P_t &= \frac{1 - \lambda}{1 - \lambda^t} \frac{1}{1 + \lambda} R, \\
\hat{P}_t &= \left( \frac{1 - \lambda}{1 - \lambda^t} \right)^2 \frac{1}{1 + \lambda} V_t(\hat{\theta}), \\
P_t &= \frac{1}{L^2} \sum_{i=1}^{t} R = R/L,
\end{align*}
\]

respectively.

Page 62 Equations (3.14)-(3.15) have time shifted parameter estimate. Should be

\[
\begin{align*}
\hat{\theta}_t &= \hat{\theta}_{t-1} - \frac{1}{2} \mu \frac{dV_t(\theta)}{d\theta} \bigg|_{\theta=\hat{\theta}_{t-1}}, \\
\hat{\theta}_t &= \hat{\theta}_{t-1} + \mu \varepsilon_t
\end{align*}
\]

to be consistent with other forms.

Page 64 \( \sigma^2 \) should be \( P_t \) in (3.23).

Page 65 \( s_t \) instead of \( y_t \) in (3.24) and (3.27) is more consequent.

Page 75 In the example, 500 data are used, not 50.

Page 77 In (3.48), minus should be plus in the sum.

Page 85 and 86 On row 4 on page 85 and row 2 on page 86, \( \sigma \) should be \( V \).

Page 85, 225 and 259 Stirling’s formula in Equation (3.57) should be

\[
\Gamma(n + 1) \approx \sqrt{2\pi n^{n+1/2}} e^{-n}.
\]
Equation (3.62) should be
\[ g_t^{\text{GLR}}(k) = \max_{\nu} 2 \log \frac{p(y_t|H_1(k, \nu))}{p(y_t|H_0)} \]

The max should be min in the expression
\[ \hat{k}^n = \arg \min_{n \geq 1, 0 < k_1 < \ldots < k_n = N} V(k^n). \]

On line 3, \( U > h \) should be \( g > h \).

Equation (5.32) should be
\[ V(\theta) = \sum_{k=1}^{t} \varepsilon_k^2(\theta). \]

Reference to Figure 5.11 should be 5.9.

Page 138 \( P_t \neq \text{Cov} \hat{\theta} \) for RLS. This implies that two occurrences of the word covariance matrix on page 138-139 should be replaced by just \( P_t \) and \( P_0 \) respectively.

On the first row, reference to Equation (5.29) should be to (5.30).

As a note to the NLMS interpretation: let \( \alpha = 1/\mu \) in (5.39). Admittedly, this is a rather peculiar version of NLMS, which behaves as something in between LMS (step size \( \mu^2 \)) and NLMS (for large regressors).

Equation (5.56) should be
\[ M(t) = \frac{V_{\text{ex}}}{V_{\min}} \to \bar{M}, \text{ as } t \to \infty. \]

The first equation in Section 5.5.1 should be
\[ \hat{\theta}_t = (I - \mu \varphi_t \varphi_t^T)(\hat{\theta}_{t-1} + v_{t-1}) - \mu \varphi_t e_t. \]

On the second last line, ascending should be descending.

The first equation in Section 5.5.2 should be
\[ \hat{\theta}_t = (I - (R_t^\varphi)^{-1}\varphi_t \varphi_t^T)(\hat{\theta}_{t-1} + v_{t-1}) - \mu \varphi_t e_t. \]
Page 149  Equation (5.63) should be
\[ s_t = (\Delta \theta_t)^T \Delta \theta_{t-1} = \varepsilon_{t-1}^T K_{t-1}^T K_t \varepsilon_t \]

Page 160  In Figure 5.27, there should be a delay in one block: \( q^{-D} D(q) \).

Page 175  On line 5, the measured slip should have a positive offset.

Page 199  On line 3, remove the factor \( \frac{1}{2} \).

Page 190  \( Y_1 \) on the middle of the page should be \( Y_x \).

Page 191  The underbrace in Equation (5.88) should be
\[ \hat{\theta}_t = \left( \sum_{k=1}^{t} \varphi_k R_k^{-1} \varphi_k^T \right)^{-1} \left( \sum_{k=1}^{t} \varphi_k R_k^{-1} y_k \right)_{f_t} = (R_t^o)^{-1} f_t. \]

Page 196  Equation (5.103) should be
\[ p(y^N) = \int_{-\infty}^{\infty} p(y^N|\theta) p(\theta) d\theta = (2\pi)^{-\frac{N+q}{2}} (\det \Lambda)^{-\frac{1}{2}} \left( \det R_0^o \right)^{\frac{q}{2}} \]
\[ \times \int_{-\infty}^{\infty} \exp \left( -\frac{1}{2} \left( (Y - \Phi^T \theta)^T \Lambda^{-1} (Y - \Phi^T \theta) + (\theta - \theta_0)^T R_0^o (\theta - \theta_0) \right) \right) d\theta \]

Page 197  The equation starting at the middle of the page should be (three errors in the exponents)
\[ p(y^N) = (2\pi)^{-\frac{Q}{2}} \left( \frac{\det R_0^o}{\det R_0^o + R_N^o} \right)^{\frac{q}{2}} \]
\[ \times \exp \left( -\frac{1}{2} \left( (Y - \Phi^T \hat{\theta}_N)^T \Lambda^{-1} (Y - \Phi^T \hat{\theta}_N) + (\hat{\theta}_N - \theta_0)^T R_0^o (\hat{\theta}_N - \theta_0) \right) \right) \]
\[ \times \int (2\pi)^{-\frac{Q}{2}} \left( \frac{\det R_0^o + R_N^o}{\det R_0^o + R_N^o} \right)^{\frac{q}{2}} \exp \left( -\frac{1}{2} \left( \theta - \hat{\theta}_N \right)^T R_0^o \left( \theta - \hat{\theta}_N \right) \right) d\theta \]
\[ = p(y^N|\hat{\theta}_N) \left( \frac{\det R_0^o}{\det R_0^o + R_N^o} \right)^{1/2} \exp \left( -\frac{1}{2} (\hat{\theta}_N - \theta_0)^T R_0^o (\hat{\theta}_N - \theta_0) \right) \]
\[ = p(y^N|\hat{\theta}_N) p_\theta(\hat{\theta}_N) (\det P_N)^{1/2} (2\pi)^{\frac{q}{2}}. \]

p. 199  r3+: remove the factor 1/2
Page 216 The signal model on top of the page should be
\[ y_k = \varphi_k^T(\theta - \theta_0) + e_k \]

Further, the distribution in the end of the example should be scaled with \( \lambda \) as
\[ \eta_L(\theta_0) \in \text{AsN} \left( \frac{\lambda}{\sqrt{L}} P_L^{-1} (\hat{\theta}_L - \theta_0), \frac{\lambda^2}{L} P_L^{-1} \right). \]

Page 219 On line 5, \( Y_0 = \Phi^T \theta_0 \).

Page 219 The term \(-\Phi^a \Delta \theta^a\) should be omitted, since it is already, implicitly, in \( Y \).

Page 219
\[ Q^a = \text{diag}(1, 0, 1, 0, \ldots, 1, 0) \Rightarrow V^a = Y^T Q^a Y = \sum_{i=\ell-L+1}^{t} (y_i^{(1)})^2 \]
\[ Q^b = \text{diag}(0, 1, 0, 1, \ldots, 0, 1) \Rightarrow V^b = Y^T Q^b Y = \sum_{i=\ell-L+1}^{t} (y_i^{(2)})^2. \]

should be
\[ \Phi^a = (1, 0, 1, 0, \ldots, 1, 0) \Rightarrow V^a = Y^T Q^a Y = \frac{1}{L} \left( \sum_{i=\ell-L+1}^{t} y_i^{(1)} \right)^2 \]
\[ \Phi^b = (0, 1, 0, 1, \ldots, 0, 1) \Rightarrow V^b = Y^T Q^b Y = \frac{1}{L} \left( \sum_{i=\ell-L+1}^{t} y_i^{(2)} \right)^2. \]

Page 222 Equation (6.14) should be
\[ V_j(\theta) = \sum_{k \in T_j} (y_k - \varphi_k^T \theta)^T (\lambda_j R_k)^{-1} (y_k - \varphi_k^T \theta), \]

p. 225 Stirlings formula is \( \ldots n^{n+1/2} \ldots \)

Page 232 Second equation should be
\[ \widehat{k^n} = \arg \min_{n \geq 1, 0 < k_1 < \cdots < k_n = N} V(k^n). \]

p. 234 (7.4)-(7.6): \( \lambda(i) \) is missing
Page 234 Equation (7.8) should be

\[ N(i) = k_i - k_{i-1}. \]

Page 235 Equation on line 2 should be

\[ p(e^N) = \prod_{i=1}^{n} \prod_{t=k_{i-1}+1}^{k_i} (2\pi\lambda(i))^{-p/2} (\det R_t)^{-1/2} \exp(-e_t^T R_t^{-1} e_t/(2\lambda(i))). \]

p. 235 (7.9): A + is missing after log det \( R_t \).

p. 259 Stirling's formula is \( \ldots n^{n+1/2} \ldots \)

Page 272-273 The \( A \) matrix in Section 8.2.3 and Example 8.4 should be transposed to get the observer canonical form.

p. 279 Equation (8.41) should be \( \ldots + K_t y_t + (I - K_t C_t) \ldots \) instead of \( \ldots + K_t y_t(I - K_t C_t) \ldots \)

p. 288 r11: \( D^k \) instead of \( D^{k-1} \)

p. 304 (8.96): Include \( + B_{u,t}u_t \).

Page 310 Line 15, reference to Section 8.9 instead of 5.5.

Page 344 Equation (9.3) should be

\[
\begin{pmatrix}
    x_{t+1} \\
    \theta_{t+1}
\end{pmatrix}
= \begin{pmatrix}
    A_t & B_{\theta,t} \\
    0 & 1
\end{pmatrix}
\begin{pmatrix}
    x_t \\
    \theta_t
\end{pmatrix}
+ \begin{pmatrix}
    B_{u,t} \\
    0
\end{pmatrix}
\begin{pmatrix}
    u_t \\
    0
\end{pmatrix}
+ \begin{pmatrix}
    B_{e,t} & B_{\theta,k}
\end{pmatrix}
\begin{pmatrix}
    v_t \\
    \delta_{t-k} \nu
\end{pmatrix}
\]

Page 353 Lemma 9.1 should be clarified as follows: If (9.1) is time invariant and \( \nu \) is unknown, then the GLR test in Algorithm 9.1 gives the same estimated change time as the MLR test in Theorem 9.8 as \( N \rightarrow \infty \) and \( k \rightarrow \infty \) if the threshold is chosen as

\[ h = -p \log(2\pi) + \log \det \tilde{R}_N(k) - 2 \log p_\nu(\tilde{\nu}) \]

when the prior of the jump is \( \nu \in N(\nu_0, P_\nu) \), and

\[ h = \log \det \tilde{R}_N(k) \]

for a flat prior. Here \( \tilde{R}_N(k) = \lim_{N \rightarrow \infty, k \rightarrow \infty} R_N(k) \), and \( R_N(k) \) is defined in Algorithm 9.1.
Page 353 Note that (3.48) follows with $p = 1$ and $R(k) = \sum_{t=k+1}^{N} 1^T R^{-1} 1 = (t - k) / R$.

Page 354 On line 3, it should be $l_N(k) = l_N(k, \nu(k)) + 2 \log p_\nu(\hat{\nu}) - \log R_N(k) + p \log(2\pi)$.

Page 354 On line 9, it should be $h_{MLR} = h_{GLR} + 2 \log p_\nu(\hat{\nu}) + p \log(2\pi) - \log \det R_N(k)$.

Page 373 Note that (9.39) can be rewritten as
\[
C_{prior}(k) = -\log \det P_\nu - (\hat{\nu}_N(k) - \nu_0)^T P_\nu^{-1} (\hat{\nu}_N(k) - \nu_0) \\
= 2 \log p_\nu(\hat{\nu}) + p \log 2\pi
\]

*p. 374* r16+ etc.: All F means A and all H means C.

*p. 399* r5+,-1: $M(\hat{\delta})$ is $S^N$.

*p. 404* (11.5): $f_t$ should be $F_t$

*p. 405* (11.8): $Tr_t = Tw^T H_f$

*p. 409* Alg 11.1: r1 in the matlab code $ Hv$ should be $ Hv$

*p. 410* r14+,-14: $f_t$ should be $F_t$

*p. 438* (12.10): $f(X|Y)$ is missing

*p. 444* r1+: increasing instead of decreasing

Page 453 The derivation of the Kalman filter using algebraic projections holds only for the scalar $y$ case. In the general case, the scalar product needs to be redefined, and a new projection theorem derived.