Errata for *Introduction to Statistical Signal Processing*
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Thanks to Ian Lee, Michael Gutmann, Frédéric Vrins, and André Isidio de Melo, and Ron Aloysius.

p. 49: The summations in (2.42)-(2.43) should run from $k = 0$ to $n - 1$, not from $k = 1$ to n as stated because the pmf is uniform on $\{0, 1, \ldots, n-1\}$ and not on $\{1, 2, \ldots, n\}$. As a result the sum in (2.42) should evaluate to $(n - 1)/2$ and not $(n + 1)/2$ and the sum in (2.43) should evaluate to $(2n - 1)(n - 1)/6$ and not $(n + 1)(2n + 1)/6$.

p. 51: Eq. (2.49) should be

$$m^{(2)} = \sum_{k=1}^{\infty} k^2 p(1-p)^{k-1} = p\left(\frac{2}{p^3} - \frac{1}{p^2}\right)$$

and not

$$m^{(2)} = \sum_{k=1}^{\infty} k^2 p(1-p)^{k-1} = p\left(\frac{2}{p^3} + \frac{1}{p^2}\right)$$

Eq. (2.50) should be

$$\sigma^2 = \frac{1-p}{p^2}$$

and not

$$\sigma^2 = \frac{2}{p^2}$$

p. 61: In (2.68) m should be $m^{(2)}$.

(2.74) is missing a π, it should be

$$\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x-m)^2/2\sigma^2}\, dx = 1$$

and not

$$\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\sigma^2}} e^{-(x-m)^2/2\sigma^2}\, dx = 1$$

p. 62 As on the previous page πs are missing. (2.75) should be

$$\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\sigma^2}} x e^{-(x-m)^2/2\sigma^2}\, dx = m$$

and not

$$\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\sigma^2}} x e^{-(x-m)^2/2\sigma^2}\, dx = m$$

and (2.76) should be

$$\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\sigma^2}} (x-m)^2 e^{-(x-m)^2/2\sigma^2}\, dx = \sigma^2$$

and not

$$\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\sigma^2}} (x-m)^2 e^{-(x-m)^2/2\sigma^2}\, dx = \sigma^2$$

p. 68: $E(g) = \lambda \sum_{x \in F} g(x)p(x) + (1-\lambda) \int_{x \in F} g(x)f(x)\, dx$ should be $E(g) = \lambda \sum_{x \in \Omega} g(x)p(x) + (1-\lambda) \int_{x \in \Omega} g(x)f(x)\, dx$

p. 75. In Problem 14 the comment "In words: if the probability of the symmetric difference of two events is small, then the two events must have approximately the same probability." belongs with Problem 2.15, not with 2.13.

p. 94 In caption of Figure 3.1 $\Pr(f \in F) = P(\{\omega : \omega \in F\}) = P(f^{-1}(F))$ should be $\Pr(f \in F) = P(\{\omega : f(\omega) \in F\}) = P(f^{-1}(F))$

p. 125:

$$P(X^{-1}(F_1) \cap Y^{-1}(F_2) = P(X^{-1}(F_1)) \cap Y^{-1}(F_2)).$$

should be

$$P(X^{-1}(F_1) \cap Y^{-1}(F_2) = P(X^{-1}(F_1))P(Y^{-1}(F_2)).$$

p. 131 Eq. (3.55) should be

$$\Lambda = \begin{bmatrix} \sigma_X^2 & \rho\sigma_X\sigma_Y \\ \rho\sigma_X\sigma_Y & \sigma_Y^2 \end{bmatrix},$$

not

$$\Lambda = \begin{bmatrix} \sigma_X^2 & \rho\sigma_X\sigma_Y \\ \rho\sigma_X\sigma_Y & \sigma_Y \end{bmatrix}$$

The second line of (3.58) should be

$$\frac{1}{2\pi\sqrt{\det\Lambda}} e^{-\frac{1}{2}(x-m_X, y-m_Y)\Lambda^{-1}(x-m_X, y-m_Y)^t}$$

and not

$$\frac{1}{\sqrt{2\pi \det \Lambda}} e^{-\frac{1}{2}(x-m_X, y-m_Y)\Lambda^{-1}(x-m_X, y-m_Y)^t}$$

p. 132 Second line, the mean should be $m_{Y|X} \triangleq m_Y + \rho(\sigma_Y/\sigma_X)(x - m_X)$ and not $m_{Y|X} \triangleq y - m_Y + \rho(\sigma_Y/\sigma_X)(x - m_X)$

The final line of (3.62) should be

$$f_{X_0}(x_0) \prod_{l=1}^{n-1} f_{X_l|X_0,\ldots,X_{l-1}}(x_l|x_0, \ldots, x_{l-1})$$

and not

$$f_{X_0}(x_0) \prod_{l=1}^{k-1} f_{X_l|X_0,\ldots,X_{l-1}}(x_l|x_0, \ldots, x_{l-1})$$

(The upper limit of the sum should be n not k)

p. 144 Eq. (3.99) should be

$$P_e = \frac{1}{2}\left(1 - \Phi\left(\frac{0.5}{\sigma_W}\right) + \Phi\left(-\frac{0.5}{\sigma_W}\right)\right) = \Phi\left(-\frac{1}{2\sigma_W}\right).$$

and not

$$P_e = \frac{1}{2}\left(1 - \Phi\left((\frac{0.5}{\sigma_W}\right) + \Phi\left(-\frac{0.5}{\sigma_W}\right)\right) = \Phi\left(\frac{1}{2\sigma_W}\right).$$

(remove extra left paren and add minus sign).

p. 145 Just above Section 3.12, $f_{X|Y}(x|y) = f_{Y|X}(y|x)f_Y(y)/f_X(x)$ should be $f_{X|Y}(x|y) = f_{Y|X}(y|x)f_X(x)/f_Y(y)$

p. 138, equation above (3.82):

$$\exp\left(-\frac{1}{2}(\frac{\alpha - m}{\sigma^2})^2\right).$$

should be

$$\exp\left(-\frac{1}{2}(\frac{\alpha - m}{\sigma})^2\right).$$

p. 149 In line equation following (3.115) should be $M_X(ju) = \mathcal{F}_{-u/2\pi}(f_X) = \mathcal{L}_{-ju}(f_X)$, that is, the subscript of $\mathcal{L}$ needs a minus sign.

p. 150 Penultimate line of (3.120) should be

$$\left\{\int_{-\infty}^{\infty} \frac{1}{(2\pi\sigma^2)^{1/2}} e^{-(x-(m+ju\sigma^2))^2/2\sigma^2}\, dx\right\} e^{jum-u^2\sigma^2/2}$$

and not

$$\left\{\int_{-\infty}^{\infty} \frac{1}{(2\pi\sigma^2)^{1/2}} e^{-(x-(m+ju\sigma^2))^2/2\sigma^2}\, dx\right\} e^{jum-y^2\sigma^2/2}$$

(the y^2 should be u^2

p. 162 Eq. (3.139)

$$\begin{aligned} & p_{Y_n|Y_{n-1},\ldots,Y_1}(y_n|y_{n-1},\ldots,y_1) \\ &= \Pr(Y_n = y_n | Y_l = y_l; l = 1,\ldots,y_{n-1}) \\ &= \Pr(X_n = y_n - y_{n-1} | Y_l = y_l; l = 1,\ldots,y_{n-1}) \\ &= \Pr(X_n = y_n - y_{n-1} | X_1 = y_1, X_i = y_i - y_{i-1};\ i = 2,3,\ldots,n-1), \end{aligned}$$

should read

$$\begin{aligned} & p_{Y_n|Y_{n-1},\ldots,Y_1}(y_n|y_{n-1},\ldots,y_1) \\ &= \Pr(Y_n = y_n | Y_l = y_l; l = 1,\ldots,y_{n-1}) \\ &= \Pr(X_n = y_n - y_{n-1} | Y_l = y_l; l = 1,\ldots,n-1) \\ &= \Pr(X_n = y_n - y_{n-1} | X_1 = y_1, X_i = y_i - y_{i-1};\ i = 2,3,\ldots,n-1), \end{aligned}$$

that is, the final index in the penultimate line is $n-1$ and not y_{n-1}.

p. 165 The sentence "The discrete time, continuous alphabet case of summing iid random variables is handled in virtually the same manner as the discrete time case, with conditional pdfs replacing conditional pmfs."

should read

"The discrete time, continuous alphabet case of summing iid random variables is handled in virtually the same manner as the discrete time, discrete alphabet case, with conditional pdfs replacing conditional pmfs."

Eq. (3.149)

$$f_{Y_1,\ldots,Y_n}(y_1,\ldots,y_n) = \prod_{l=1}^{k-1} f_{Y_l|Y_1,\ldots,Y_{l-1}}(y_l|y_1,\ldots,y_{l-1}).$$

should read

$$f_{Y_1,\ldots,Y_n}(y_1,\ldots,y_n) = \prod_{l=1}^{n} f_{Y_l|Y_1,\ldots,Y_{l-1}}(y_l|y_1,\ldots,y_{l-1}).$$

That is, the upper limit of the product should be n.

Eq. (3.152)

$$f_{Y_1,\ldots,Y_n}(y_1,\ldots,y_{n-1}) = \prod_{i=1}^{n} f_X(y_i - y_{i-1})$$

should read

$$f_{Y_1,\ldots,Y_n}(y_1,\ldots,y_n) = \prod_{i=1}^{n} f_X(y_i - y_{i-1})$$

that is, the final index on the left is n, not $n-1$.

p. 184 Eighth line following (4.1), $r_n^{(n)}$ should be $r_a^{(n)}$.

p. 185 Eq. (4.4)

$$E(X) = \sum_{x\in A} a p_X(x)$$

should be

$$E(X) = \sum_{x\in A} x p_X(x)$$

p. 210:

$$\begin{aligned}
f_{Y|X}(y|x) &= \frac{f_{XY}(x,y)}{f_Y(y)} \\
&= \frac{\exp\left(-(1/2)((x-m_X)^t\ (y-m_Y)^t)K_U^{-1}\begin{pmatrix} x-m_X \\ y-m_Y \end{pmatrix}\right)}{\sqrt{(2\pi)^{(k+m)}\det K_U}} \\
&\quad \times \frac{\sqrt{(2\pi)^k \det K_X}}{\exp\left(-(x-m_X)^t K_X^{-1}(x-m_X)/2\right)} \\
&= \frac{1}{\sqrt{(2\pi)^m \det K_X / \det K_U}} \\
&\quad \times \exp\left(-(1/2)((x-m_X)^t\ (y-m_Y)^t)K_U^{-1}\begin{pmatrix} x-m_X \\ y-m_Y \end{pmatrix}\right. \\
&\qquad\qquad \left. + (x-m_X)^t K_X^{-1}(x-m_X)\right)
\end{aligned}$$

should be

$$
\begin{aligned}
f_{Y|X}(y|x) &= \frac{f_{XY}(x,y)}{f_X(y)} \\
&= \frac{\exp\left(-(1/2)((x-m_X)^t\ (y-m_Y)^t)K_U^{-1}\begin{pmatrix} x-m_X \\ y-m_Y \end{pmatrix}\right)}{\sqrt{(2\pi)^{(k+m)}\det K_U}} \\
&\quad \times \frac{\sqrt{(2\pi)^k \det K_X}}{\exp\left(-(x-m_X)^t K_X^{-1}(x-m_X)/2\right)} \\
&= \frac{1}{\sqrt{(2\pi)^m \det K_U / \det K_X}} \\
&\quad \times \exp\left(-(1/2)((x-m_X)^t\ (y-m_Y)^t)K_U^{-1}\begin{pmatrix} x-m_X \\ y-m_Y \end{pmatrix}\right. \\
&\qquad \left. + (1/2)(x-m_X)^t K_X^{-1}(x-m_X)\right)
\end{aligned}
$$

p. 289, the $K_Y(k,j)$E should read

$$\sigma^2 r^{|k-j|}\frac{1-r^{2(min(k,j)+1)}}{1-r^2}.$$

p. 303, the last line in the top equation should read

$$\lim_{N\to\infty}\sum_{k=-(N-1)}^{N-1}(1-\frac{|k|}{N})R_X(k)e^{-i2\pi fk}$$

and not

$$\lim_{N\to\infty}\frac{1}{N}\sum_{k=-(N-1)}^{N-1}(1-\frac{|k|}{N})R_X(k)e^{-i2\pi fk}$$

that is, the extra $1/N$ should be removed.

p. 324: Replace

$$\sum_{n=-\infty}^{\infty}\frac{1}{2W}x\left(\frac{n}{2W}\right)\frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T}$$

by

$$\sum_{n=-\infty}^{\infty}x\,(nT)\,\frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T}$$

p. 325: Replace (5.101)

$$R_X(t-\tau) = \sum_{n=-\infty}^{\infty} R_X\left(\frac{n}{2W} - \tau\right) \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T}.$$

by

$$R_X(t-\tau) = \sum_{n=-\infty}^{\infty} R_X\left(nT - \tau\right) \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T}.$$

p. 326: Replace the first equation

$$R_X(0) = \sum_{n=-\infty}^{\infty} R_X\left(\frac{n}{2W} - t\right) \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T}.$$

by

$$R_X(0) = \sum_{n=-\infty}^{\infty} R_X\left(nT - t\right) \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T}.$$

Replace the penultimate equation in the proof

$$\sum\sum\nolimits_{n,m:n-m=k} \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T} \frac{\sin(\pi(t-mT)/T)}{\pi(t-mT)/T}$$
$$= \sum_{n=-\infty}^{\infty} \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T} \frac{\sin(\pi(\frac{t}{T}-(n-k)))}{\pi(\frac{t}{T}-(n-k))} = \frac{\sin(\pi(\frac{t}{T}-k))}{\pi(\frac{t}{T}-k)},$$

by

$$\sum\sum\nolimits_{n,m:n-m=k} \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T} \frac{\sin(\pi(t-mT)/T)}{\pi(t-mT)/T}$$
$$= \sum_{n=-\infty}^{\infty} \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T} \frac{\sin(\pi(t+kT-nT)/T)}{\pi(t+kT-nT)/T} = \frac{\sin(\pi k)}{\pi k},$$

Replace the final equation in the proof (just above section 5.8.7)

$$\lim_{N\to\infty} \sum_{n=-N}^{N} \sum_{m=-N}^{N} R_X((n-m)T) \frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T} \frac{\sin(\pi(t-mT)/T)}{\pi(t-mT)/T}$$
$$= \sum_{-\infty}^{\infty} R_X(k) \frac{\sin(\pi(\frac{t}{T}-k))}{\pi(\frac{t}{T}-k)} = R_X(0)$$

by

$$\lim_{N\to\infty}\sum_{n=-N}^{N}\sum_{m=-N}^{N} R_X((n-m)T)\frac{\sin(\pi(t-nT)/T)}{\pi(t-nT)/T}\frac{\sin(\pi(t-mT)/T)}{\pi(t-mT)/T}$$

$$=\sum_{-\infty}^{\infty} R_X(k)\frac{\sin(\pi k)}{\pi k} = R_X(0)$$

p. 330: Near the middle of the page, change
If R_X has a Fourier series expansion

$$R_X(\tau) = \sum_{n=-\infty}^{\infty} b_n e^{j2\pi nt/T}$$

to
If R_X has a Fourier series expansion

$$R_X(\tau) = \sum_{n=-\infty}^{\infty} b_n e^{j2\pi n\tau/T}$$

and just below it change
then the integral equation to be solved for the Karhunen–Loeve expansion is

$$\lambda\phi(t) \;=\; \int_0^T \sum_{n=-\infty}^{\infty} b_n e^{j2\pi nt/T}\phi(s)\,ds = \sum_{n=-\infty}^{\infty} b_n \int_0^T e^{j2\pi n(t-s)/T}\phi(s)\,ds.$$

to then the integral equation (5.107) to be solved for the Karhunen–Loeve expansion is

$$\lambda\phi(t) \;=\; \int_0^T \sum_{n=-\infty}^{\infty} b_n e^{j2\pi n(t-s)/T}\phi(s)\,ds = \sum_{n=-\infty}^{\infty} b_n \int_0^T e^{j2\pi n(t-s)/T}\phi(s)\,ds.$$

p. 435, Problem A.23 (b) has a typo and as a result the integral blows up. It should be replaced by

$$\int_0^\infty dx e^{-x}\int_0^x dy e^{-y}.$$

p. 439 (B.7) should be

$$\sum_{k=0}^{\infty} k^2 q^{k-1} = \frac{2q}{(1-q)^3} + \frac{1}{(1-q)^2}$$

instead of

$$\sum_{k=0}^{\infty} k^2 q^{k-1} = \frac{2}{(1-q)^3} + \frac{1}{(1-q)^2}$$

The second line of the next equation should be

$$\frac{1}{q}\sum_{k=0}^{\infty} k^2 q^{k-1} - \frac{1}{q}\sum_{k=0}^{\infty} k q^{k-1} = \frac{1}{q}\sum_{k=0}^{\infty} k^2 q^{k-1} - \frac{1}{(1-q)^2 q}$$

instead of

$$\frac{1}{q}\sum_{k=0}^{\infty} k^2 q^{k-1} - \frac{1}{q}\sum_{k=0}^{\infty} k q^{k-1} = \frac{1}{q}\sum_{k=0}^{\infty} k^2 q^{k-1} - \frac{1}{(1-q)^2}$$

The final equation of the proof should be

$$\sum_{k=0}^{\infty} k^2 q^{k-1} = \frac{2q}{(1-q)^3} + \frac{1}{(1-q)^2},$$

instead of

$$\sum_{k=0}^{\infty} k^2 q^{k-1} = \frac{2}{(1-q)^3} + \frac{1}{(1-q)^2},$$

p. 442 (B.13) should be changed from

$$\begin{aligned}\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\sigma^2}} e^{-(x-m)^2/2\sigma^2}\,dx &= \frac{1}{\sqrt{2\sigma^2}}\int_{-\infty}^{\infty} e^{-r^2}\,\sigma\,dr \\ &= \frac{\sqrt{2\pi}}{\sqrt{2\pi}} = 1.\end{aligned}$$

to

$$\begin{aligned}\int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x-m)^2/2\sigma^2}\,dx &= \frac{1}{\sqrt{2\pi\sigma^2}}\int_{-\infty}^{\infty} e^{-r^2/2}\,\sigma\,dr \\ &= \frac{\sqrt{2\pi}\sigma}{\sqrt{2\pi\sigma^2}} = 1.\end{aligned}$$

p. 446: **Uniform pmf**. $\Omega = \mathcal{Z}_n = \{0, 1, \ldots, n-1\}$ and $p(k) = 1/n$; $k \in \mathcal{Z}_n$.
mean: $(n+1)/2$

variance: $(2n+1)(n+1)n/6 - ((n+1)/2)^2$.
should be

Uniform pmf. $\Omega = \mathcal{Z}_n = \{0, 1, \ldots, n-1\}$ and $p(k) = 1/n$; $k \in \mathcal{Z}_n$.
mean: $(n-1)/2$
variance: $(2n-1)(n-1)/6 - [(n-1)/2]^2 = (n^2-1)/12$.

The variance of the geometric pmf should be $(1-p)/p^2$, not $2/p^2$.

p. 447, the mean of the Uniform pdf should be $(b+a)/2$ and not $(b-a)/2$. The variance of the Gamma pdf is a^2b and not ab.