Errata for

Foundations of

Computational Imaging

A Model Based Approach

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This document contains errors that have been found in the text since its publication. The Section 1 contains errors found during its first printing, and the Section 2 contains errors found during its second printing.

So if you own a version of the text that was printed on or before 2024, you will want to use corrections from both sections. But if you have a version of the text from the second printing, they you will only need corrections from Section 2.

If you find any error, please email me at bouman@purdue.edu or Charles.Bouman@gmail.com, and I will add your error to this list, so it can be corrected in future printings of the book.

Thank you so much for your support!

Charles A. Bouman

1 First Printing Corrections:

This section contains the list of errors that were corrected in the second printing of the book. If you own a copy of the book printed on or before 2024, use both these

1. Chapter 1: page 6: line 10: (Thanks Jim Fowler!)
   "Then the "thickness" of the manifold at the location $X_r, r \neq s$, is approximately σ_s.
   $\Rightarrow$
   "Then the "thickness" of the manifold at this location is approximately σ_s.

2. Chapter 2: page 18:
   "... to determine the function, $T : \Re^n \rightarrow \Omega$, that..."
   $\Rightarrow$
   "... to determine the function, $T : \Re^p \rightarrow \Omega$, that..."

3. Chapter 2: page 19: footnote: (Thanks Jim Fowler!)
   $$\lim_{n\rightarrow\infty} P_\theta\{|\theta - \hat{\theta}| > \varepsilon\} = 0$$
   $\Rightarrow$
   $$\lim_{n\rightarrow\infty} P_\theta\{|\theta - \hat{\theta}_n| > \varepsilon\} = 0$$

4. Chapter 3: page 36:
   "Since the combination of ε and $X_0, \cdots, X_{n-1}$ is jointly Gaussian, ..."
   $\Rightarrow$
   "Since the combination of ε and $X_1, \cdots, X_{n-1}$ is jointly Gaussian, ..."

5. Chapter 4: page 57: "Example 4.2" $\rightarrow$ "Example 4.1"

6. Chapter 5: page 73: (Thanks Vivek Goyal!)
   The constant α in equation (5.29) is defined differently from the constant α in the previous sections and in particular in equation (5.13).

   So in order to keep the definition of α consistent with the previous section, the following corrections should be make to equations in Section 5.3.3.

   $$\text{(5.23 correction)} \qquad d^{(k)} = -\sigma^2 \nabla f\left(x^{(k)}\right)$$
   $$\text{(5.28 correction)} \qquad d^{(k)} = A^t(y - Ax^{(k)}) - \sigma^2 Bx^{(k)}$$
   $$\text{(5.29 correction)} \qquad \alpha^{(k)} = \frac{\|d^{(k)}\|^2}{\|d^{(k)}\|_H^2}$$

7. Chapter 7: page 100: line 10: (Thanks Jim Fowler!)
   "Moreover, if the function $f(x)$ is strictly convex, than any such global minimum will be unique."
   $\Rightarrow$
   "Moreover, if the function $f(x)$ is strictly convex, then any such global minimum will be unique."

8. Chapter 8: page 114: bottom of page
"It can be shown that in fact the constraint is met for any potential function ... that the influence function is convex for $\Delta < 0$."
$\Rightarrow$
"It can be shown that in fact the constraint is met for any symmetric potential function whose associated influence function, $\rho'(\Delta)$, is monotone increasing near $\Delta = 0$, and concave for $\Delta > 0$. (See problem 3)"

9. Chapter 8: page 118: line 14: above equation (8.23): (Thanks Jim Fowler!)
"...where it can be shown that (See problem 4)..."
$\Rightarrow$
"...where it can be shown that..."
Actually, there is a missing problem that should have label
`\label{hw:DerivativesForGeneralLineSearch}`.

10. Chapter 8: page 120: Problem 3
Reword problem to be:
"Assume that potential function $\rho(\Delta)$ has the following properties:
a) $\rho(\Delta)$ is a symmetric function of Δ,
b) $\rho'(\Delta)$ is defined for $\Delta > 0$,
c) $\lim_{\Delta\downarrow 0}\rho'(\Delta) \geq \lim_{\Delta\uparrow 0}\rho'(\Delta)$,
d) $\rho'(\Delta)$ is a concave for $\Delta > 0$.
Then prove that the symmetric bound surrogate function of (8.17) produces an upper bound to the true function."

11. Chapter 9: Page 135:
"The cart moves toward the bottom of the function $f(x)$, but it is restricted by..."
$\Rightarrow$
"The cart moves toward the bottom of the function $u(x)$, but it is restricted by..."

12. Chapter 9: Page 147: Problem 9(a):
The v should be a y.

13. Chapter 9: Page 148: Problem 10:
(This correction is in addition to the Second Printing correction of Section 2 item 6.) There is a missing square in the formula for $F(v)$ and some errors in the specification of the distributions for X and W. It should be:

Define the proximal map of $u(x)$ as

$$F(v) = \arg\min_{x\in\mathbb{R}^N}\left\{u(x) + \frac{1}{2\sigma^2}\|x-v\|^2\right\}$$

a) Show that when $u(x;y) = \frac{1}{2}\|y-Ax\|_\Lambda^2$, then

$$F(v;y) = v + \left(I + A^t\Lambda A\right)^{-1} A^t\Lambda(y-Av) \ .$$

where the function $F(v;y)$ shows the explicit dependence on y.

b) Show that $F(v;Y)$ has an interpretation as the MAP estimate of X given Y under the assumption that

$$Y = AX + W ,$$

where X and W are independent Gaussian random vectors with $X \sim N(v, \sigma^2 I)$ and $W \sim N(0, \Lambda^{-1})$.

14. Chapter 10: Page 154: line 7: (Thanks Jim Fowler!)
"When $F(x)$ and $H(x)$ are the proximal maps from equation (10.3),..."
$\Rightarrow$
"When $F(x)$ and $H(x)$ are the proximal maps from equations (10.2) and (10.3),..."
Actually, this is because there is a missing reference of
`equations~(\ref{eq:ProximalMap1}) and~(\ref{eq:ProximalMap2})`

15. Chapter 10: Page168: Problem 1(b):
"Hint: Choose $u^* = \sigma^2 \nabla f(\hat{x})$" $\Rightarrow$ "Hint: Choose $u^* = -\sigma^2 \nabla f(\hat{x})$"

16. Chapter 14: Page 224, line 8:: (Thanks Jim Fowler!)

$$P\{X_s = x_s | X_r \text{ for } r \neq s\} = P\{X_s = x_s | X_{\partial r}\} ,$$

$\Rightarrow$

$$P\{X_s = x_s | X_r \text{ for } r \neq s\} = P\{X_s = x_s | X_{\partial s}\} ,$$

17. Chapter 14: Page 224, line 10: (Thanks Jim Fowler!)

$$P\{X_s \in A | X_r \text{ for } r \neq s\} = P\{X_s \in A | X_{\partial r}\} ,$$

$\Rightarrow$

$$P\{X_s \in A | X_r \text{ for } r \neq s\} = P\{X_s \in A | X_{\partial s}\} ,$$

18. Chapter 14: Page 224, line 17: (Thanks Jim Fowler!)

$$p(x) \neq \prod_{s \in S} p(x_s | x_{\partial r})$$

$\Rightarrow$

$$p(x) \neq \prod_{s \in S} p(x_s | x_{\partial s})$$

19. Appendix B: Page 315, line 14: (Thanks Jim Fowler!)
"Intuitively, a function is nonexpansive if it has a Lipschitz constant less than one."
$\Rightarrow$
"Intuitively, a function is contractive if it has a Lipschitz constant less than one."

2 Second Printing Corrections:

This section contains the list of errors for the second printing of the book. Use this list if your book was printed on or after 2025.

1. Chapter 2: Chapter Problems: Problem 13: Page 32
   "d) Calculate an expression for the conditional variance of X given Y."
   $\Rightarrow$
   "d) Calculate an expression for the conditional **covariance** of X given Y."

2. Chapter 6: Section 6.3: Page 89
   "... and $\forall \lambda \in \Re$,
   $$\rho\left(\lambda a + (1-\lambda)\right) \leq \lambda \rho(a) + (1-\lambda)\rho(b) \ .''$$
   $\Rightarrow$
   "... and $\forall \lambda \in [0,1]$,
   $$\rho\left(\lambda a + (1-\lambda)b\right) \leq \lambda \rho(a) + (1-\lambda)\rho(b) \ .$$

3. Chapter 9: Problem 1: Page 146

   "Let $f : \mathscr{A} \to \mathbb{R}$ is a convex function on the non-empty convex set $A \subset \mathbb{R}^N$,..."
   $\Rightarrow$
   "Let $f : \mathscr{A} \to \mathbb{R}$ be a continuous convex function on the non-empty closed convex set $\mathscr{A} \subset \mathbb{R}^N$,..."

4. Chapter 9: Problem 2: Page 146
   $$\hat{x} = \arg \min_{\substack{x \in \mathbb{R}^{+N} \\ Cx - b \in \mathbb{R}^{+N}}} f(x) \ ,$$
   ...
   $$\hat{x} = \arg \min_{\substack{z \in \mathbb{R}^{+N} \\ Bz = c}} f(z) \ ,$$
   $\Rightarrow$
   $$\hat{x} = \arg \min_{\substack{x \in \mathbb{R}^{+N} \\ Cx - b \in \mathbb{R}^{+K}}} f(x) \ ,$$
   ...
   $$\hat{x} = \arg \min_{\substack{z \in \mathbb{R}^{+(N+K)} \\ Bz = c}} f(z) \ ,$$

5. Chapter 9: Problem 9: Page 147

   $$H(y) = \left(I + \sigma^2 B\right)^{-1} v \ .$$

$\Rightarrow$

$$H(y) = \left(I + \sigma^2 B\right)^{-1} y \, .$$

6. Chapter 9: Problem 10: Page 148
   This correction is in addition to the First Printing correction of Section 1 item 13.

$$F(v;y) = v + \left(I + A^t \Lambda A\right)^{-1} A^t \Lambda \left(y - Av\right) \, .$$

$\Rightarrow$

$$F(v;y) = v + \left(\frac{1}{\sigma^2} I + A^t \Lambda A\right)^{-1} A^t \Lambda \left(y - Av\right) \, ,$$

7. Chapter 9: Problem 11 part a: Page 148

$$H(y) = F^{-1} \left(I + \sigma^2 \Lambda\right)^{-1} F v \, ,$$

$\Rightarrow$

$$H(y) = F^{-1} \left(I + \sigma^2 \Lambda\right)^{-1} F y \, ,$$

8. Appendix A: Problem 3: Page 313
   "...on the convex set $\mathscr{A} \subset \mathbb{R}^N$, then it is a continuous function for all $x \in \mathscr{A}$."
   $\Rightarrow$
   "...on the convex set $\mathscr{A} \subset \mathbb{R}^N$, then it is a continuous function for all $x \in \mathrm{int}(\mathscr{A})$."