

Errata for

Foundations of Computational Imaging

A Model Based Approach

Charles A. Bouman

Purdue University

Published by SIAM, 2022

Last updated on August 30, 2026

For copies from the *second* printing

This document lists all known errors in the **second printing** of the book. To identify your printing, look in the upper left of the copyright page, where a row of digits appears. The smallest number in the row is the printing number.

So if you have the second printing, it should look like this:

Copyright © 2022 by the Society for Industrial and Applied Mathematics
10 9 8 7 6 5 4 3 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 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: Problem 5b: Page 31 (Thanks Harel Dor!)
 “Prove that if for all i, j , X_i and X_j are uncorrelated”
 $\Rightarrow$
 “Prove that if for all $i \neq j$, X_i and X_j are uncorrelated”
2. 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 .”

3. Chapter 3: Page 43 (Thanks Harel Dor!)
In equation (3.15) and the density expression below it, the sum is over $r \in W$, but W is undefined; it should be the prediction window W_P defined on page 42.
4. Chapter 3: Problem 3: Page 45 (Thanks Harel Dor!)
Part b) does not specify the prediction variance needed for the plots. It should read: “Plot $S_X(\omega)$ and $R_X(n)$ for $\rho = 0.5$ and $\rho = 0.95$, with $\sigma^2 = 1$.”
5. Chapter 3: Problem 6: Page 45 (Thanks Harel Dor!)
The condition “if $x_n = 0$ for $n \leq 0$ and $n > N$ ” is both incorrectly stated and unnecessary, since x_n is only defined for $0 \leq n \leq N - 1$ and circular convolution requires no such condition. The problem should simply read: “Show that $y = Ax$, where A is a circulant matrix.”
6. Chapter 4: Property 4.2: Page 56
“A stationary discrete time-zero-mean Gaussian random process”
 $\Rightarrow$
“A stationary discrete-time zero-mean Gaussian random process”
7. Chapter 4: Section 4.6: Page 58
“we may formally define for a GMRF.”
 $\Rightarrow$
“we may formally define a GMRF.”
8. Chapter 5: Section 5.3: Page 70
“because H is formed by the sum of two positive-definite matrices”
 $\Rightarrow$
“because H is the sum of a positive semidefinite and positive definite matrix”
 $A^t A$ is positive semidefinite in general; $\sigma^2 B$ is positive definite, which is what makes the eigenvalues of H strictly positive.
9. Chapter 5: Section 5.4: Pages 76–77
In the definition of l_s below the equation for h_s , the two conditions are reversed:
“ $l_s = h_s$ if $s < 0$, and $l_s = 0$ if $s \geq 0$ ”
 $\Rightarrow$
“ $l_s = h_s$ if $s > 0$, and $l_s = 0$ if $s \leq 0$ ”
 L is the strictly lower triangular part of H , so l_s is supported on positive indices, as Example 5.2 already assumes. Also, in Example 5.2 the left-hand sides l_s and d_s of the closing display should be l_n and d_n , to match the right-hand sides.
10. Chapter 5: Section 5.4: Page 77
In the frequency domain error update equation above the definition of $P(\omega)$:
“ $\epsilon^{(k+1)}(\omega) = \left(\frac{-L^*(\omega)}{L(\omega) + h_0} \right)^k \epsilon^{(0)}(\omega)$ ”
 $\Rightarrow$
“ $\epsilon^{(k)}(\omega) = \left(\frac{-L^*(\omega)}{L(\omega) + h_0} \right)^k \epsilon^{(0)}(\omega)$ ”
Iterating the matrix update k times from $\epsilon^{(0)}$ gives the k^{th} iterate with exponent k .
11. Chapter 6: Figure 6.2: Page 88
In the first row of the table, the weak-spring potential:

“ $\min \{|\Delta|^2, T\}$ ”

$\Rightarrow$

“ $\min \{|\Delta|^2, T^2\}$ ”

The text’s definition with T^2 is correct: the transition then occurs at $|\Delta| = T$, as the caption of Figure 6.1 states.

12. Chapter 6: Section 6.3: Page 89 (Thanks Vivek Goyal!)

“... and $\forall \lambda \in \Re$,

$$\rho(\lambda a + (1 - \lambda)) \leq \lambda \rho(a) + (1 - \lambda) \rho(b) .”$$

$\Rightarrow$

“... and $\forall \lambda \in [0, 1]$,

$$\rho(\lambda a + (1 - \lambda)b) \leq \lambda \rho(a) + (1 - \lambda) \rho(b) .$$

13. Chapter 7: Section 7.2: Page 100

In the paragraph introducing line search, two sentences call the starting point $x^{(k)}$ while the equations that follow use $x^{(k-1)}$ as the start and $x^{(k)}$ as the result:

“start with an initial value, $x^{(k)}$ ” and “passing through the initial point $x^{(k)}$ ”

$\Rightarrow$

“start with an initial value, $x^{(k-1)}$ ” and “passing through the initial point $x^{(k-1)}$ ”

14. Chapter 8: Section 8.1: Page 110

“it must also be the case that $f(\tilde{x}^*) < f(x')$ ”

$\Rightarrow$

“it must also be the case that $f(\tilde{x}^*) \leq f(x')$ ”

The two surrogate conditions give $f(\tilde{x}^*) \leq q(\tilde{x}^*; x') \leq q(x'; x') = f(x')$, and the inequality can hold with equality, for example when x' is already the minimizer.

15. Chapter 8: Section 8.2: Page 111

... substitute for $f(x)$ in the optimization.

$\Rightarrow$

... substitute for $q(x)$ in the optimization.

16. Chapter 8: Problem 3: Page 120

“d) $\rho'(\Delta)$ is a concave for $\Delta > 0$.”

$\Rightarrow$

“d) $\rho'(\Delta)$ is concave for $\Delta > 0$.”

17. Chapter 9: Page 127: footnote

“take vales in the extended real line”

$\Rightarrow$

“take values in the extended real line”

18. Chapter 9: Problem 1: Page 146

“Then prove that $g: \mathbb{R}^N \rightarrow \mathbb{R}$ is a proper, closed, and convex function.”

$\Rightarrow$

“Then prove that $g: \mathbb{R}^N \rightarrow \mathbb{R} \cup \{\infty\}$ is a proper, closed, and convex function.”

and also

“Let $f: \mathcal{A} \rightarrow \mathbb{R}$ is a convex function...”

$\Rightarrow$

“Let $f: \mathcal{A} \rightarrow \mathbb{R}$ be a continuous convex function on the non-empty closed convex set $\mathcal{A} \subset \mathbb{R}^N, \dots$ ”

19. Chapter 9: Problem 2: Page 146

Corrected problem notation:

Consider the optimization problem

$$\hat{x} = \arg \min_{\substack{x \in \mathbb{R}^{+N} \\ Cx - b \in \mathbb{R}^{+K}}} f(x) ,$$

where $x \in \mathbb{R}^N$, $b \in \mathbb{R}^K$, and $C \in \mathbb{R}^{K \times N}$. Then define the new vector

$$z = \begin{bmatrix} x \\ y \end{bmatrix}$$

where $y \in \mathbb{R}^K$ and $y = Cx - b$. Then show that there is an equivalent constrained optimization problem with the form

$$\hat{x} = \arg \min_{\substack{z \in \mathbb{R}^{+(N+K)} \\ Bz = c}} \tilde{f}(z) ,$$

for $\tilde{f}(z) = f(x)$ and some appropriately chosen matrix B and vector c . The variable y is sometimes referred to as a **slack variable**.

20. Chapter 9: Problem 9: Page 147

In the second printing, Problem 9 was inadvertently replaced with a near duplicate of Problem 10, so the intended problem was lost. Problem 9 should read:

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

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

a) Show that when $u(x) = \frac{1}{2} x^T B x$, then

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

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

$$Y = X + W ,$$

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

21. Chapter 9: Problem 10: Page 148

This correction is in addition to the correction of this problem in item 13 of the first-printing errata document.

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

$\Rightarrow$

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

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

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

$\Rightarrow$

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

23. Chapter 10: Figure 10.4 caption: Page 155

“then the results is the conventional MAP estimate”

$\Rightarrow$

“then the result is the conventional MAP estimate”

24. Chapter 10: Theorem 10.2: Page 159

In the proof of the reverse direction of Theorem 10.2, the choice of u^* has the wrong sign:

“and we choose $u^* \in \sigma^2 \nabla f(x^*)$ ”

$\Rightarrow$

“and we choose $u^* \in -\sigma^2 \nabla f(x^*)$ ”

25. Chapter 10: Page 165 (Thanks Harel Dor!)

In the text above and below equation (10.25), the components $\mathbf{w}_k$ should not be bold; they should be typeset as w_k . Bold $\mathbf{w}$ denotes only the full stacked state.

26. Chapter 12: Example 12.7: Page 195

“ $P\{X_n = m\} = \pi_m$ for $0 \leq m < M - 1$ ”

$\Rightarrow$

“ $P\{X_n = m\} = \pi_m$ for $0 \leq m < M$ ”

27. Chapter 12: Page 197

“the so-called Aikake information criterion (AIC)”

$\Rightarrow$

“the so-called Akaike information criterion (AIC)”

28. Chapter 12: Page 198: Step 3b (Thanks Harel Dor!)

“ $\text{MDL}(M) \leftarrow \text{MDL}(M, \theta^*)$ ”

$\Rightarrow$

“ $\text{MDL}(M) \leftarrow \text{MDL}(M, \theta_M^*)$ ”

29. Chapter 14: Page 225

“Cliques are sets of point which are all neighbors”

- ⇒
 “Cliques are sets of points which are all neighbors”
30. Chapter 14: Page 231
 “so by the Hammersly–Clifford theorem”
 ⇒
 “so by the Hammersley–Clifford theorem”
31. Chapter 14: Figure 14.3 caption: Page 232
 “Notice that the probably that $X_s = 1$ increases”
 ⇒
 “Notice that the probability that $X_s = 1$ increases”
32. Chapter 14: Page 233
 “by a outer boundary of values, B .”
 ⇒
 “by an outer boundary of values, B .”
33. Chapter 16: Page 266
 “While assuming this type of product can be extremely useful”
 ⇒
 “While assuming this type of product form can be extremely useful”
34. Chapter 17: Page 289
 The cross-reference is broken and prints as “Section ??”. The sentence should end:
 “...in a manner similar to that used for the potential functions in Section 8.3.”
35. Chapter 17: Problem 3: Page 303
 The summation index should be j , not i , in both sums:
 $Y = \sum_{i=1}^N Z_j$ and $\lambda = \sum_{i=1}^N \lambda_j$
 ⇒
 $Y = \sum_{j=1}^N Z_j$ and $\lambda = \sum_{j=1}^N \lambda_j$
36. Appendix A: Problem 3: Page 313
 “...on the convex set $\mathcal{A} \subset \mathbb{R}^N$, then it is a continuous function for all $x \in \mathcal{A}$.”
 ⇒
 “...on the convex set $\mathcal{A} \subset \mathbb{R}^N$, then it is a continuous function for all $x \in \text{int}(\mathcal{A})$.”
37. Appendix B: Page 318
 “By Theorems B.5 and B.6”
 ⇒
 “By Properties B.5 and B.6”

2 Minor Corrections and Clarifications:

The following are minor corrections and clarifications that do not directly affect the reader’s understanding, but should be incorporated in any future printing.

1. Chapter 2: Problem 16: Page 33 (Thanks Harel Dor!)
The matrix A is the only matrix in the problem whose dimensions are not given; it should be defined as $A \in \mathbb{R}^{M \times N}$.
2. Chapter 3: Example 3.1: Page 40
“we will assume that $X_n = 0$ when $n < 0$ ”
 $\Rightarrow$
“we will assume that $X_n = 0$ when $n \leq 0$ ”
The prediction error $\mathcal{E}_1$ uses X_0 , so the assumption should cover $n = 0$. Problem 10 of Chapter 3 already states the assumption this way.
3. Chapter 3: Example 3.2: Page 43
“As before, we will assume that $X_s = 0$ when $s_1 < 0$ or $s_2 < 0$.”
 $\Rightarrow$
“As before, we will assume that $X_s = 0$ when $s_1 \leq 0$ or $s_2 \leq 0$.”
The same clarification as in Example 3.1: the prediction window uses pixels with zero or negative coordinates, so the assumption should cover them.
4. Chapter 3: Problem 10: Page 47 (Thanks Harel Dor!)
There is a spurious comma in the equation defining $\hat{C}$, between the sum and the equals sign.
5. Chapter 7: Page 102 (Thanks Harel Dor!)
In the KKT conditions, there is no separation between each condition and its equation; a comma should follow each “such that” clause.
6. Chapter 7: Section 7.3: Page 104
Below the constrained ICD update equation:
“enforces that the updated pixel is positive”
 $\Rightarrow$
“enforces that the updated pixel is nonnegative”
At $\alpha = -x_s$ the updated pixel is exactly zero.
7. Chapter 8: Section 8.3: Page 113
“the best choice tends to depend on the specific structure of the potential function being minimized”
 $\Rightarrow$
“the best choice tends to depend on the specific structure of the potential function”
The potential function is bounded by the surrogate; the MAP cost function is what is minimized.