

**Errata:**  
**An Introduction to Optimization, Fourth Edition**  
by  
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**Typos and minor changes: Printings 1–3**

- p. 12, second line from bottom: Remove one of the two repeated instances of “use.”
- p. 15, line 5: Add to the end of the sentence: “Moreover, it follows from properties 1 and 2 that the determinant of a matrix with two identical columns, not necessarily next to each other, is always 0.” [Thanks to Zain Khandwala.]
- p. 52, four lines from bottom: Change “convex polytope” to “polyhedron”. (Unfortunately, the definitions of *polytope* and *polyhedron* are not universal, so the original text is still consistent with some definitions in the literature.)
- p. 52, caption of Figure 4.10: Change to “Polyhedra.”
- p. 52, three lines from bottom: Change “A nonempty bounded polytope is called a *polyhedron*” to “A nonempty bounded polyhedron is called a *polytope*”. (Unfortunately, the definitions of *polytope* and *polyhedron* are not universal, so the original text is still consistent with some definitions in the literature.)
- p. 53, caption of Figure 4.11: Change “polyhedron” to “polytope”.
- p. 94, Exercise 6.7: In the right-hand side of the equation, change  $f(\mathbf{y})$  to  $f(\mathbf{y} - \mathbf{x}_0)$ . [Thanks to Brandon Van Over.]
- p. 98, Exercise 6.20: Add the following after the last sentence: “The position  $x \in \mathbb{R}$  is unconstrained.” [Thanks to Brandon Van Over.]
- p. 144, Example 8.3: In line 8, change “ $\mathbf{x}^{(k)} \rightarrow 0$ ” to “ $\mathbf{x}^{(k)} \rightarrow \mathbf{x}^*$ ”. In the second displayed equation, change “ $\frac{1}{2}$ ” at the right-hand side of the inequality to “0”. In the last line, add the following in between “ $k$ .” and “Hence”: “, showing that the condition  $\sum_{k=0}^{\infty} \gamma_k = \infty$  fails.” [Thanks to Yuwei Jheng.]
- p. 148, line 15: Change “reflects that fact” to “reflects the fact”. [Thanks to Nikica Hlupić.]
- p. 153, line 2, just after “... not an eigenvector of  $\mathbf{Q}$ ”: Insert “, which has distinct eigenvalues (because  $\lambda_{\max}(\mathbf{Q}) > \lambda_{\min}(\mathbf{Q})$ ).”
- p. 153, line 3: Add negative sign in front of “ $(\mathbf{x}^{(k+1)} - \mathbf{x}^{(k)})$ ”; the equation should read  $\mathbf{g}^{(k)} = -(\mathbf{x}^{(k+1)} - \mathbf{x}^{(k)})/\alpha_k$ . [Thanks to Yuwei Jheng.]
- p. 153, line 10, just after “... corresponding to  $\lambda_{\max}(\mathbf{Q})$  and  $\lambda_{\min}(\mathbf{Q})$ ”: Insert “, assumed unequal.”

- p. 162, line 4: Replace “objection function” by “objective function” [thanks to Ali Pezeshki].
- p. 171, Exercise 9.1 question: At the end of the question after “minimizing  $f$ ” append “with iterates  $x^{(0)}, x^{(1)}, x^{(2)}, \dots$ ”
- p. 173, Exercise 9.4, part b: At the end of the question after “Newton’s method” append “(with unit step size).”
- pp. 177–178, proof of Theorem 10.1: Change the symbol  $\beta$  to some other symbol, like  $\eta$ , so that there won’t be any confusion with the same symbol used in Section 10.3.

- p. 201, equation four lines from bottom: Add  $\top$  next to the leftmost superscript ( $k$ ). The equation should be

$$\Delta \mathbf{g}^{(k)\top} (\Delta \mathbf{x}^{(k)} - \mathbf{H}_k \Delta \mathbf{g}^{(k)})$$

[Thanks to Vishal Shetty.]

- p. 202, part of Example 11.2: Replace the part of the example from the first displayed equation with the following:

$$f(\mathbf{x}) = (x_2 - x_1)^4 + 12x_1x_2 - x_1 + x_2 - 3$$

with an initial point

$$\mathbf{x}^{(0)} = [-0.5262, 0.6014]^\top$$

and initial matrix

$$\mathbf{H}_0 = \begin{bmatrix} 0.1186 & -0.0376 \\ -0.0376 & 0.1191 \end{bmatrix}.$$

Note that  $\mathbf{H}_0 > 0$ . We have

$$\Delta \mathbf{g}^{(0)\top} (\Delta \mathbf{x}^{(0)} - \mathbf{H}_0 \Delta \mathbf{g}^{(0)}) = -0.00076948$$

and

$$\mathbf{H}_1 = \begin{bmatrix} 0.0331 & 0.0679 \\ 0.0679 & -0.0110 \end{bmatrix}.$$

It is easy to check that  $\mathbf{H}_1$  is not positive definite (it is indefinite, with eigenvalues 0.0824 and  $-0.0603$ ).

[Thanks to Julio Gonzalez-Saenz for pointing out the need to change the numerical values in this example.]

- p. 281, second paragraph, line 2, change “step 5” to “step 3”. [Thanks to Nikica Hlupić.]
- p. 284, line 8: Replace “ $\mathbf{g}^{(k+1)} = \mathbf{x}_i^{(k+1)}$ ” by “ $\mathbf{g}^{(k+1)} = \arg \min_{\mathbf{x} \in \{\mathbf{x}_1^{(k+1)}, \dots, \mathbf{x}_d^{(k+1)}\}} f(\mathbf{x})$ ”.
- p. 287, 8 lines from bottom: Change “left” to “right” (should be “... right of the crossing site”).
- p. 290, last line: Change “8-bit” to “16-bit.”
- p. 316, eight lines from bottom: Change “polytope” to “polyhedron” (two occurrences).

- p. 316, seven lines from bottom: Change “polyhedron” to “polytope”. Same with occurrences of “polyhedron” six, four, three, and two lines from the bottom. (Unfortunately, the definitions of *polytope* and *polyhedron* are not universal, so the original text is still consistent with some definitions in the literature.)
- p. 317, Figure 15.4 caption and line two: Change “polyhedron” to “polytope”. (Unfortunately, the definitions of *polytope* and *polyhedron* are not universal, so the original text is still consistent with some definitions in the literature.)
- p. 539, line 4: Change “gep” to “gevp” in the MATLAB command.
- p. 539, line 7: Change “ $C(\mathbf{x}) \leq D(\mathbf{x}), C(\mathbf{x}) \leq D(\mathbf{x})$ ” to “ $C(\mathbf{x}) \leq D(\mathbf{x}), 0 \leq B(\mathbf{x})$ ” (the second inequality should be  $0 \leq B(\mathbf{x})$ ).
- p. 550, line 19 (middle of page): Change “define  $\mathbf{y} = \Pi[\mathbf{x}] \in \mathbb{R}^n$ ” to “define “ $\mathbf{y} = \Pi[\mathbf{x}] \in \Omega$ ” (change  $\mathbb{R}^n$  to  $\Omega$ ; not strictly an error, but to improve the exposition). [Thanks to Nikica Hlupić.]
- p. 558, proof of Theorem 23.2, 8th line (just above first displayed equation): Change “ $\mathbb{R}^{n \times m} \rightarrow \mathbb{R}^{n \times m}$ ” to “ $\mathbb{R}^{n+m} \rightarrow \mathbb{R}^{n+m}$ ” ( $\times$  should be  $+$ ). [Thanks to Nikica Hlupić.]
- p. 582, second bullet item (line 9): Insert “nor is dominated by” between “dominate” and “any” (should be “ $\mathbf{x}^j$  does not dominate nor is dominated by any existing candidate solutions”). [Thanks to Nikica Hlupić.]
- p. 582, end of line 13 and beginning of line 14: Insert “nor is dominated by” between “dominate” and “any” (should be “ $\mathbf{x}^j$  does not dominate nor is dominated by any existing candidate solutions”). [Thanks to Nikica Hlupić.]
- p. 583–584, Algorithm for Generating a Pareto Front: In step 2, line 2, change “candidate solutions” to “solutions to be generated”.  
In step 4, change the displayed inequality to “ $f_i(\mathbf{x}^j) \leq f_i(\mathbf{x}^{*r})$ ” (i.e., should be  $\leq$ , not  $<$ ), and just after the inequality add “and  $f_i(\mathbf{x}^j) < f_i(\mathbf{x}^{*r})$  for at least one  $i$ ”. [Thanks to Nikica Hlupić.]  
In step 4, delete “ $\mathbf{f}^{*R} := \mathbf{f}(\mathbf{x}^j)$ ,”.  
In step 5, just after the displayed inequality add “and  $f_i(\mathbf{x}^j) > f_i(\mathbf{x}^{*r})$  for at least one  $i$ ”.  
In step 7, delete “, add  $\mathbf{x}^j$  as a new candidate Pareto solution, and go to step 2”.
- p. 611, index entry for “polyhedron” under “Convex set”: Change 317 to 316.
- p. 611, index entry for “polytope” under “Convex set”: Change 316 to 316, 317. (Unfortunately, the definitions of *polytope* and *polyhedron* are not universal, so the original text is still consistent with some definitions in the literature.)
- p. 609, Index: All page numbers above 348 are probably one to five pages lower than they should be. Some examples shown below:
  - p. 610, index entry for “Bland’s rule”: Change 375 to 376.

- p. 612, index entry for “dual nonlinear program” under “Duality”: Change 543 to 546.
- p. 612, index entry for “duality theorem” under “Duality”: Change 543 to 547.
- p. 612, index entry for “weak duality lemma” under “Duality”: Change the page numbers to 387, 401, 547.
- p. 612, index entry for “dual quadratic program” under “Duality”: Change 399 to 401.
- p. 612, index entry for “primal quadratic program” under “Duality”: Change 399 to 401.
- p. 612, index entry for “quadratic programming” under “Duality”: Change 399 to 401.
- p. 612, index entry for “Duality theorem”: Change 543 to 547.
- p. 612, index entry for “Lagrangian” under “Function”: Change 543 to 547.
- p. 612, index entry for “utility” under “Function”: Change 542 to 546.
- p. 615, index entry for “Klee-Minty problem”: Change 401 to 403.
- p. 615, index entry for “Lagrangian function”: Change 543 to 547.
- p. 615, index entry for “Bland’s rule” under “Linear programming”: Change 375 to 376.
- p. 615, index entry for “Klee-Minty problem” under “Linear programming”: Change 401 to 403.
- p. 616, index entry for “Lyapunov inequality”: Change the page numbers to 531, 547.
- p. 616, index entry for “MATLAB”: Change 543 to 547.
- p. 617, index entry for “Minimax”: Change the page numbers to 581, 586, 590.
- p. 615, index entry for “Minty”: Change 401 to 403.
- p. 618, index entry for “Primal nonlinear program”: Change 542 to 546.
- p. 618, index entry for “Primal quadratic program”: Change 399 to 401.
- p. 619, index entry for “Proportional fairness”: Change the page number to 545.
- p. 619, index entry for “Quadratic programming”: Change the page numbers to 401, 476, 485, 504.
- p. 620, index entry for “Bland’s rule” under “Simplex method”: Change 375 to 376.
- p. 621, index entry for “Singular value decomposition”: Change the page number to 575.
- p. 621, index entry for “Subgradient”: Change the page numbers to 519, 541.
- p. 622, index entry for “Utility function”: Change 542 to 546.
- p. 622, index entry for “Weak duality lemma”: Change the page numbers to 387, 401, 547.