Errata for *Linear and Geometric Algebra* 
Printings 1-3

p. 64, Problem 9.2.16. Theorem 9.3 $\rightarrow$ Corollary 9.3.
Errata for *Linear and Geometric Algebra*
Printings 1-2,
and four new problems

p. 3, paragraph 3 (improved wording). Parallel lengths with the same norm and orientation are different geometric objects. Nevertheless, we will consider them equal. In other words, we ignore their position.

p. 22, Definition 2.5. Add at the end (for clarity): “We say that $V$ spans $\text{span}(V)$.”

p. 39, second paragraph after Definition 3.4. Eq. (3.2)) $\rightarrow$ (Eq. (3.3).

p. 54, Exercise 4.6. Ans. $\cos \theta = \frac{32}{(14 \times 77)^{\frac{1}{2}}}$.

p. 54, Exercise 4.7. Ans. $\frac{32}{77}(4e_1 + 5e_2 + 6e_3)$.

p. 65, Part (b). The parenthesis in “(We can also . . . ” should close at the end of the paragraph.

p. 73, Section 5.1, paragraph 4 (improved wording). Recall that parallel lengths with the same norm and orientation are considered equal. Similarly, parallel areas (i.e., areas in nonintersecting planes) with the same norm and orientation are considered equal. In other words, we ignore their shape and position. Thus $\mathbf{B}$ in the figure is equal to the interior of a parallelogram with the same norm and orientation in a parallel plane.

p. 75, replace last two sentences of Note 1. The sum $\mathbf{B}_1 + \mathbf{B}_2$ of nonzero oriented areas in the two planes does not represent an oriented area.

p. 75, remove Note 3.

p. 79, paragraph 4 (improved wording). Volumes with the same orientation and norm are considered equal. In other words, we ignore their shape and position.

p. 88, Problem 5.4.4. “three” $\rightarrow$ “first” and remove “they satisfy”. Replace the last paragraph with “Using the full series shows that $e^{i\theta} = \cos \theta + i \sin \theta$.”

p. 90, Figure 5.19. $-(2\pi - \theta) \rightarrow 2\pi - \theta$.

Exercise 5.26. $R_i(2\pi-\theta)(\mathbf{u}) = R_{i\theta}(\mathbf{u}) \rightarrow R_i(\theta-2\pi)(\mathbf{u}) = R_{i\theta}(\mathbf{u})$

p. 92, new Problem 5.5.9. Prove Rodrigues’ formula for a rotation around axis $\mathbf{n}$ ($|\mathbf{n}| = 1$) by scalar angle $\theta$:

$$R(\mathbf{n}, \theta)x = \cos \theta x + \sin \theta (\mathbf{n} \times x) + (1 - \cos \theta)(\mathbf{n} \cdot x)\mathbf{n}.$$ 

p. 93, second sentence. “Theorem 1.2” $\rightarrow$ “Theorem 1.8”.

p. 98. Add immediately after Definition 6.7 for clarity:

“(So a $k$-blade is a $k$-vector, but a $k$-vector need not be a $k$-blade.)”
p. 101, end. \[ \sum_{j,k=0}^{n} a_j b_k \rightarrow \sum_{j,k=1}^{n} a_j b_k. \]

p. 103, Eq (6.9). “\( k - j \)” \( \rightarrow \) “\( j + k \)”

p. 106, Theorem 6.18, proof. Theorem 6.17c \( \rightarrow \) Theorem 6.17g.

p. 109, Problem 6.4.2. Problem 6.1.1 \( \rightarrow \) Definition 6.10.

p. 122, Theorem 7.4c proof. “we need to verify Part (d)” \( \rightarrow \) “we need to verify Part (c)”.

p. 122, Theorem 7.4 proof, last line. “Exercise 6.1.2” \( \rightarrow \) “Problem 6.1.2”.

p. 125, under Composition of rotations. Should read \( Z_1 = e^{-i\theta_1/2} \) and \( Z_2 = e^{-i\theta_2/2} \).

p. 131, Problem 7.3.2. The answer is \( e_1 + 3e_3 \).

p. 131, Problem 7.3.9a. Change the hint to: Use Theorem 7.9.

p. 131, last paragraph. “if we imagine” \( \rightarrow \) “in the special case”.


p. 144, Exercise 8.16. “Eq. (8.7)” \( \rightarrow \) “Eq. (8.8)”.

p. 152, Problem 8.4.3. “a vector space \( V \)” \( \rightarrow \) “\( \mathbb{R}^n \)”.

p. 158, Problem 9.1.8. Add to the hypotheses that \( f \) is one-to-one.

p. 158, Problem 9.1.9. Problem should read: Find a formula similar to Eq. (9.4) for bases which are not orthonormal. Use reciprocal bases (Problem 6.5.8).

p. 165, Two new problems.

9.2.20 Prove Theorem 9.13 again using the geometric meaning of the determinant.

9.2.7 Show that only 1 and 0 can be eigenvalues of a projection \( P \). Hint: From Problem 7.1.4, \( P^2 = P \).


“Choose the smallest \( m \) so that the \( m \) vectors . . . .” \( \rightarrow \)

“Choose the smallest \( m \) so that the \( m + 1 \) vectors . . . .”

p. 167, lines -5 and -6:

\[ f^2(u) + bf(u) + ci(u) = (f^2 + bf + ci)(u) = (f^2 + bf + ci)q(f)(v) = p(f)(v) = 0. \]

p. 168, Problem 9.3.3c. “Hint: Start with \( \mathcal{K}(f|_B) = \{0\} \)” \( \rightarrow \)

“Hint: Start with \( \mathcal{K}(f|_B) = \{0\} \)”

p. 174, Lemma 9.27. Add “or reflection” to the end of the statement of the lemma.
p. 175, below Eq. (9.17):

“According to Lemma 9.27, there are three possibilities:” →

“According to Lemma 9.27, there are four possibilities:”

p. 175, Theorem 9.16. Add to proof:

(iv) \( f \) has an invariant 2-dimensional subspace on which it is a reflection. By Lemma 9.27 and Problem 5.5.5 this is a composition of Cases (i) and (ii), and so reduces to them.

p. 180, new Problem 9.6.8:

a. Show that a skew transformation has an eigenvector.

b. Show that a skew transformation has an orthonormal basis of eigenvectors.

p. 184, Problem 9.7.1b. The matrix \( A \) must be square.

p. 198, top. \texttt{numpy.set_printoptions(precision=3)} → \texttt{set_printoptions(precision=3)}

p. 200, line 5. Change to “\( B \).exp() e^B \).”
Errata for *Linear and Geometric Algebra*  
first printing only

p. vii, footnote. “available the” → “available at the”.

p. viii, line 22. “definition a determinant” → “definition of a determinant”.

p. 8, line 10. “Ordered triples \((x, y, z)\)” → “Ordered pairs \((x, y, z)\)”.

p. 8, Theorem 1.3c. “[0] = (0, 0, 0)” → “[0] = (0, 0)”.

p. 13, Theorem 1.8, line 4. “\(V^n\)” → “\(V\)”.

p. 14, Problem 1.2.4. “Theorem 1.2” → “Theorem 1.3”.

p. 16, line 1. “\(\mathbb{L}^3\) and \(\mathbb{L}^3\) obey satisfy” → “\(\mathbb{L}^2\) and \(\mathbb{L}^3\) satisfy”.

p. 19, Problem 2.1.3. “The vector \(-v\) is that” → “The vector \(-v\) is the”.

p. 19, Problem 2.1.6a. Change to “Let \(a(x, y) = (ay, ax)\) be the usual scalar multiplication on pairs \((x, y)\). Define \((x_1, y_1) + (x_2, y_2) = (0, 0)\). Does this define a vector space?”

p. 20, Theorem 2.3 statement. “Let \(U\) set” → “Let \(U\) be a set”.

p. 20, Theorem 2.3. “0 ∈ \(V\)” → “0 ∈ \(U\)”.

p. 25, Theorem 2.9b, proof. Should read “Since the vectors \(v_1, \ldots, v_r\) ... , i.e., the vectors \(v_2, \ldots, v_r\) are linearly independent.”

p. 30, Theorem 2.20b. Add “for \(V\)” at the end of the statement.

p. 32, -12 (up from the bottom), “all vector spaces” → “all finite dimensional vector spaces”.

p. 35, Eq. (3.5) should read:

\[
\begin{bmatrix}
 m \\
 \end{bmatrix}
\begin{bmatrix}
 m \\
 \end{bmatrix} =
\begin{bmatrix}
 n \\
 \end{bmatrix} \\
\text{(Mnemonically: \((n \times m) \times (m \times 1) = n \times 1\))}
\]

p. 36, line 2: “\((n \times m) \times (m \times p) = n \times p\)”.

p. 36, line 5: “\(n\)-dimensional” → “\(m\)-dimensional”.

p. 36, Eq. (3.9). “\(ai_nb_{nk}\)” → “\(a_{im}b_{mk}\)”.

p. 49, Problem 3.2.2c. “\(b \in \mathbb{R}^3\)” → “\(b \in \mathbb{R}^2\)”.

p. 49, Problem 3.2.5. Change to “Suppose \(A\) is an \(n \times n\) matrix with \(Ax = \mathbf{0}\) for some \(x \neq \mathbf{0}\). Is there a unique solution to \(Ax = b\) for every \(b\)? Explain.”

p. 56, Problem 4.2.2a. Change to read “Describe the entries of the \(k \times k\) matrix \(A^*A\) in terms of the \(v\)'s.”
p. 58, Equation above Fig. 4.7 should read $|\mathbf{u} + \mathbf{v}|^2 = |\mathbf{u}|^2 + |\mathbf{v}|^2 - 2|\mathbf{u}||\mathbf{v}| \cos \theta$ as in the figure caption.

p. 59. Last line of proof of Theorem 4.14: “Schwartz” → “Schwarz”.

p. 62, Problem 4.3.14a should reference Theorem 3.2.

p. 64, prior to Eq. (4.15): Now subtract from $\mathbf{u}_2$ its projection on $\mathbf{b}_1$ ...

p. 65, line 1: ... its projections on $\mathbf{b}_1$ and $\mathbf{b}_2$ ...

p. 67, Eq. (4.18). “$(\mathbf{v} \cdot \mathbf{e}_{i+1}) \mathbf{e}_{i+1}$” → “$(\mathbf{v} \cdot \mathbf{e}_{r+1}) \mathbf{e}_{r+1}$”.

p. 68, bottom. Here is a non-Java least squares demo: http://demonstrations.wolfram.com/LeastSquaresCriteriaForTheLeastSquaresRegressionLine/

p. 69, Problem 4.4.3. The basis $\mathbf{e}_i$ must be orthonormal.

p. 75, Note 3. The last sentence should read “Moreover, a clockwise orientation viewed from one side is counterclockwise when viewed from the other.”

p. 76, end of first paragraph: “Its orientation is given by the way $\mathbf{u}$, the first vector in the product $\mathbf{u} \wedge \mathbf{v}$, points along the boundary.”

p. 79. The paragraph starting with “Three oriented lengths placed tail-to-tail determine an oriented volume $\mathbf{u} \wedge \mathbf{v} \wedge \mathbf{w}$, their outer product.” should continue “The trivectors $\mathbf{u} \wedge \mathbf{v} \wedge \mathbf{w}$ and $-(\mathbf{u} \wedge \mathbf{v} \wedge \mathbf{w})$ have opposite orientations.”

p. 84, paragraph following Exercise 5.13. Improved:

A unit pseudoscalar $\mathbf{i}$ determines exactly one plane. Thus “the plane $\mathbf{i}$” can serve as an abbreviation for “the plane with unit pseudoscalar $\mathbf{i}$”. This usage is similar to the abbreviation “the point $(2, 4)$” for “the point with coordinates $(2, 4)$”. These are useful shortenings, but please be clear that oriented planes and points are geometric objects, whereas $\mathbf{i}$ and $(2, 4)$ are their mathematical representations.

p. 84, Exercise 5.14a, first sentence: “The square of a real scalar cannot be negative.”

p. 85, Definition 5.16, should read: “... is a member of $\mathbb{G}^n$ ... ”

p. 88, Problem 5.4.1, last $\theta_1$ should be $\theta_2$.

p. 91, Eq. (5.18) should read $\cos 60^\circ - \frac{\mathbf{e}_1 - \mathbf{e}_4 + \mathbf{e}_5}{\sqrt{3}} \mathbf{I} \sin 60^\circ$.

p. 92, Problem 5.5.6, should read: Verify Step (3) in Eq. (5.14).

p. 98, very end: Theorem 5.15 → Theorem 5.24.

p. 104, Problem 6.3.3, change to “Show that $\mathbf{u}^2 \mathbf{v}^2 = (\mathbf{u} \cdot \mathbf{v})^2 - (\mathbf{u} \wedge \mathbf{v})^2$ by factoring the right side.”

p. 105, line 8: for $\rightarrow$ form.

p. 111, Theorem 6.21, first sentence should read: “Let $\mathbf{a}$ be a vector and $\mathbf{B}$ a $k$-blade.”
p. 113, second line of proof of Theorem 6.23 should read: “\( A \neq a_1 \cdots a_{j-1} c \)”.  

p. 115, Eq. (6.21) should read:  
\[
b^i = (-1)^{i-1}(b_1 \land b_2 \land \cdots \land \hat{b}_i \land \cdots \land b_n)/(b_1 \land b_2 \land \cdots \land b_n).
\]

p. 115, Problem 6.5.8e, should read: Use the expansions \( u = \sum_i u_i b^i \) and \( v = \sum_j v^j b_j \) to obtain a formula for \( u \cdot v \).  

p. 115, last sentence of footnote: “This book does not take it up.” → “This book does not take it up.”  

p. 116, Theorem 6.26b: “is volume” → “is the volume”.  

p. 119, Proof of Theorem 7.1: “Theorem 6.15” → “Eq. (4.17)”.  

p. 120, projection definition. “is the blade” → “is”.  

p. 121, Theorem 7.3. Strike “the blade”. (The projection might be zero.)  

p. 126, Eq. (7.12). Elaboration of justification of Step (2): Separate \( M \land N \) into its parts, and then use Parts (a) and (d).  


p. 129, line 14. “depend the way” → “depend on the way”.  

p. 131, Problem 7.3.9c. All “\( R \)”s → “\( F \)”s.  

p. 138, Exercise 8.5a. \( f(u) \to f(u) \).  

p. 141, “Below \( R(f) \) ... remaining vectors in \( V \)” → “below \( 0 \) are the remaining vectors in \( V \).”  

p. 146, line 8. “less than of” → “less than or”.  

p. 146, Theorem 8.14b. “\( \mathcal{K}(f) \perp \)” → “\( \mathcal{K}(A) \perp \)”.  

p. 150, Problem 8.3.2. “Now adapt Eq. (7.9) ... .” → “Now adapt Eq. (7.9).”  

p. 153, line 10. “representation an an” → “representation as an”  

p. 157, following Theorem 9.9. “\( i \)th column” → “\( i \)th row”.  

p. 157, Theorem 9.10. Change Parts (a)-(c) to refer to columns and Part (d) to refer to rows.  

p. 158, Problem 9.1.11. “For Part (e)” → “For Part (d)”.  

p. 160. Delete the first sentence.  

p. 163, Problem 9.2.8. “\( M_B \)” → “\( F_B \)”.  

p. 170. “\((-a + d) \pm \sqrt{(a - d)^2 + 4b^2}\)” → “\((a - d \pm \sqrt{(a - d)^2 + 4b^2}\)”. 
p. 171, last line. “Cauchy-Schwartz” → “Cauchy-Schwarz”.


p. 176, Problem 9.5.4, better version: Suppose that a subspace \( U \) of a vector space \( V \) is invariant under an orthogonal transformation \( f \). Show that \( U^\perp \) is also invariant under \( f \). \textit{Hint:} Use Problem 8.1.15b.

p. 176, Problem 9.5.7. Strike the word “symmetric”.

p. 177, Lemma 9.31, second sentence. “\( f(b_1) \)” → “\( f(e_1) \)”.

p. 191, paragraph -2. Should read “\( n^2 - n + 41 \) is a prime number”, and “\((41)^2 - 41 + 41 = 41^2\)”, which is not a prime.