CORRECTIONS TO

Introduction to Topological Manifolds

(Second Edition)

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(2/25/18) **Page xii, last paragraph:** Allen Hatcher's name is misspelled. (Sorry, Allen.)

(2/14/15) **Page 23, Exercise 2.6, first line:** Change "collection of topologies" to "nonempty collection of topologies."

(6/24/19) **Page 26, just above Exercise 2.12:** Replace the last sentence of the paragraph by "Symbolically, this is denoted by $x_i \to x$."

(6/18/19) **Page 27, paragraph before Proposition 2.19:** Just before the last sentence of that paragraph, insert "(Continuity of the restriction of a function to an open subset is understood to be with respect to the topology described in Exercise 2.5.)"

(3/8/16) **Page 27, last line:** Change two occurrences of x to y in the displayed equation, so it reads

$$\left(f|_{V_x}\right)^{-1}(U) = \{y \in V_x : f(y) \in U\} = f^{-1}(U) \cap V_x,$$

(9/26/19) **Page 31, second paragraph below the section heading, second sentence:** Change "two points" to "two distinct points."

(6/24/19) **Page 32, just above Exercise 2.38:** Insert the following sentence: "In view of the preceding proposition, in a Hausdorff space we can write $p = \lim_{i\to\infty} p_i$ as an alternative notation for $p_i \to p$."

(5/17/12) **Page 37, three lines from the bottom:** Change "Exercise 2.49" to "Example 2.49."

(11/26/15) **Page 53, part (c) of the proposition continued from the previous page:** Insert another "if" after "if and only."

(7/14/18) **Page 58, second display:** Replace k by $k/2$ (twice) and l by $l/2$ (twice). [The tangent and cotangent functions have period π, not 2π.]

(9/26/19) **Page 60, last paragraph:** In this paragraph and in the first one on page 61, change all subscript k's to n's (a total of four times).

(9/26/19) **Page 61, Proposition 3.31, part (c):** Change X_k to X_n.

(11/20/19) **Page 66, after the second line:** Add the following sentence: "We sometimes also say informally that Y is a quotient space of X when Y is a topological space that has the quotient topology with respect to some continuous map from X to Y."

(3/23/12) **Page 67, Example 3.52, second sentence:** Change this sentence to read "Let $\sim$ be the equivalence relation on X such that $a_1 \sim a_2$ for all $a_1, a_2 \in A$ and $x \sim x$ for all other $x \in X$; the partition ...."

(5/17/12) **Page 67, Example 3.53, last line:** Change $\mathbb{B}^n$ to $\overline{\mathbb{B}}^{n+1}$.

(7/17/19) **Page 70, Example 3.66, first paragraph, next-to-last line:** Change θ to $\frac{1}{2\pi}\theta$.

(10/7/11) **Page 74, line 5:** Change this statement to read "*As a set, $X \cup_f Y$ is the disjoint union ....*" [The topology on $X \cup_f Y$ is not the disjoint union topology.]

(4/1/22) **Page 74, Example 3.78(a):** Change "topological spaces" to "Hausdorff spaces."

(11/30/19) **Page 75, proof of Theorem 3.79, second line:** Change $q(\partial M \cup \partial N)$ to $q(\partial M \amalg \partial N)$.

(6/4/21) **Page 75, proof of Theorem 3.79, second paragraph:** Replace that paragraph with the following: "Suppose $s \in S$, and let $y_0 \in \partial N$ and $x_0 = h(y_0) \in \partial M$ be the two points in the fiber $q^{-1}(s)$. We can choose coordinate charts (U,φ) for M and (V,ψ) for N such that $x_0 \in U$ and $y_0 \in V$, and let $\widehat{U} = \varphi(U)$, $\widehat{V} = \psi(V) \subseteq \mathbb{H}^n$ (Fig. 3.13). It is useful in this proof to identify $\mathbb{H}^n$ with $\mathbb{R}^{n-1} \times [0,\infty)$ and $\mathbb{R}^n$ with $\mathbb{R}^{n-1} \times \mathbb{R}$. By shrinking U and V if necessary, we may assume that $h(V \cap \partial N) = U \cap \partial M$. Then we can write the coordinate maps as $\varphi(p) = (\varphi_0(p), \varphi_1(p))$ and $\psi(p) = (\psi_0(p), \psi_1(p))$ for some continuous maps $\varphi_0\colon U \to \mathbb{R}^{n-1}$, $\varphi_1\colon U \to [0,\infty)$, $\psi_0\colon V \to \mathbb{R}^{n-1}$, $\psi_1\colon V \to [0,\infty)$. Our assumption that x_0 and y_0 are boundary points means that $\varphi_1(x_0) = \psi_1(y_0) = 0$, and there are open subsets $U_0, V_0 \subseteq \mathbb{R}^{n-1}$ such that $\varphi_0(U \cap \partial M) = U_0$, $\psi_0(V \cap \partial N) = V_0$. (Here we are again using the theorem on invariance of the boundary.) After replacing U and V by the preimages of $U_0 \times [0,\infty)$ and $V_0 \times [0,\infty)$, respectively, we can also assume that $\widehat{U} \subseteq U_0 \times [0,\infty)$ and $\widehat{V} \subseteq V_0 \times [0,\infty)$."

(6/18/19) **Page 76, display in the middle of the page:** Change y^n to y_n (twice).

(7/16/11) **Page 76, last paragraph of the proof of Theorem 3.79:** In the second line of the paragraph, change "embedding of N" to "embedding of M." In the fourth line, change "embedding of M" to "embedding of N."

(8/8/17) **Page 87, Exercise 4.3:** Insert "nonempty" before "connected."

(8/23/11) **Page 87, Exercise 4.4:** Insert another "if" after "if and only."

(8/23/11) **Page 88, proof of Proposition 4.9, fourth paragraph:** In the first sentence of that paragraph, change "open subsets of $\bigcup_{\alpha\in A} B_\alpha$" to "open subsets of X whose union contains $\bigcup_{\alpha\in A} B_\alpha$."

(10/18/22) **Page 89, line above Proposition 4.11:** Change "Appendix B" to "Appendix A."

(10/18/22) **Page 93, proof of Proposition 4.26, last sentence:** Change "X is connected ..." to "if X is nonempty, it is connected ...."

(8/23/11) **Page 97, line 10:** Change $B_{n_{\max}}(a)$ to $B_{n_{\max}}(x)$.

(3/9/11) **Page 98, line 3 from bottom:** Change "this proposition" to "this lemma."

(6/21/20) **Page 99, second paragraph:** Delete the second sentence of the paragraph. [It's not wrong; it's just not needed.]

(6/21/20) **Page 103, just above Exercise 4.58:** After the word "illustrates," insert "(using the theorem on invariance of the boundary)."

(6/19/21) **Page 104, proof of Proposition 4.60:** Delete the last sentence in the first paragraph, and in the second paragraph, replace the phrase "r is any positive rational number strictly less than $r(x)$" by "r is any positive rational number such that $B_{2r}(x) \subseteq \widehat{U}_i$."

(6/19/21) **Page 106, proof of Theorem 4.68, last paragraph:** After the first sentence of the paragraph, insert: "Begin by setting $W_0 = U$." Then in the third and fourth lines of the paragraph, replace "Choosing $r_n < \min(\varepsilon_n, 1/n)$" by "Choosing $r_n < \min(\varepsilon_n, 1/n)$ and setting $W_n = B_{r_n}(x_n)$."

(8/23/11) **Page 106, line 3 from the bottom:** Change "countable union" to "countable intersection."

(8/23/11) **Page 109, statement of Lemma 4.74:** Insert another "if" after "if and only."

(7/19/15) **Page 110, next-to-last line:** Change M to X.

(8/23/11) **Page 114, proof of Corollary 4.83:** This proof is incorrect. Replace it with the following: "Given a closed subset $A \subseteq X$ and a neighborhood U of A, Lemma 4.80 shows that there is a neighborhood V of A such that $\overline{V} \subseteq U$. By Urysohn's lemma, there exists a continuous function $f: X \to [0,1]$ such that $f \equiv 1$ on A and $f \equiv 0$ on $X \smallsetminus V$. This function satisfies $\operatorname{supp} f \subseteq \overline{V} \subseteq U$, so it is the bump function we seek."

(6/17/19) **Page 119, statement of Proposition 4.93(b):** Add the hypothesis that Y is Hausdorff.

(10/24/19) **Page 119, proof of Proposition 4.93, second paragraph:** Change the first sentence to read "To prove (b), assume X is a second countable Hausdorff space and Y is Hausdorff, and suppose ...." Then replace the sentence beginning "Suppose on the contrary" by the following: "Suppose on the contrary that (x_i) is a sequence in L with no convergent subsequence in L. Because Y is Hausdorff, K is closed and therefore so is L, which means that (x_i) has no convergent subsequence in X."

(8/23/11) **Page 121, proof of Lemma 4.94:** Replace the last two sentences of the proof with the following: "Thus x lies in the closure of $A \cap K$ in K. Because $A \cap K$ is closed in K, it follows that $x \in A \cap K \subseteq A$."

(8/23/11) **Page 123, Problem 4-15(d):** Change "every connected neighborhood" to "every neighborhood."

(9/16/11) **Page 126, Problem 4-30:** Change $\{A_\alpha\}$ to $\{X_\alpha\}_{\alpha\in A}$.

(4/12/20) **Page 126, Problem 4-31(c):** In the last sentence, change "every element of $\mathcal{U}$" to "every nonempty element of $\mathcal{U}$."

(4/12/20) **Page 128, proof of Prop. 5.1:** Insert before the first sentence of the proof: "The proposition is true by definition when $n = 0$, so assume that $n > 0$."

(7/4/22) **Page 130, third paragraph, lines 5 and 6:** "Homeomorphism" is misspelled.

(3/20/21) **Page 133, line above Theorem 5.6:** Change "an n-dimensional subcomplex" to "a subcomplex of dimension at most n."

(1/20/11) **Page 133, proof of Proposition 5.7:** This should refer to Problem 5-8, not 5-7.

(5/17/12) **Page 136, four lines below the displayed equations:** Change "both X'_{n-1} and X''_{n-1} are open" to "both X'_n and X''_n are open."

(1/20/11) **Page 137, statement of Lemma 5.13:** Change "*discrete*" to "*closed and discrete*."

(1/20/11) **Page 137, proof of Lemma 5.13, first paragraph:** In line 1, change "discrete" to "closed and discrete"; and in line 2, change "discrete subset" to "closed discrete subset."

(1/20/11) **Page 137, proof of Theorem 5.14, second paragraph:** Change "infinite discrete subset" to "infinite closed discrete subset."

(7/17/19) **Page 140, displayed formulas:** In both displayed formulas, change $\mathbb{R}$ to $[0,1]$.

(4/12/20) **Page 141, just above the displayed equation:** In the line above the display and in the display itself, change A to B (four times), to avoid conflict with the use of A as the index set for the open cover.

(4/12/20) **Page 141, displayed equation:** Change D_γ^{n+1} to $D_\gamma^{n+1} \smallsetminus \{0\}$.

(9/16/11) **Page 141, line 5 from the bottom:** Change $\widetilde{U}_\alpha^{n+1}$ to $\widetilde{U}_{\alpha_i}^{n+1}$ (twice).

(2/5/13) **Page 141, line 4 from the bottom:** Change "the minimum" to "one-half the minimum."

(2/5/13) **Page 141, line 3 from the bottom:** Change "supported in $\partial D_\gamma^{n+1}(\varepsilon/2)$" to "supported in $D_\gamma^{n+1} \smallsetminus \partial D_\gamma^{n+1}(\varepsilon/2)$"

(7/17/19) **Page 143, proof of Proposition 5.24, last paragraph:** Change $U \cap e_0$ to $U \cap \bar{e}_0$.

(10/16/20) **Page 144, three lines above Lemma 5.26:** Change "the finite subcomplex $\mathcal{E}_n$" to "the finite subcomplex M_n."

(7/24/19) **Page 145, second paragraph:** Change e_n to e_k twice (once in the first line, and once in (5.1)).

(7/22/19) **Page 146, Case 1, second paragraph:** Change Y_n to Y_{v_n} (twice).

(4/12/20) **Page 152, sentence after the proof of Prop. 5.38:** Change $i = 1, \dots, k$ to $i = 0, \dots, k$.

(3/24/11) **Page 156, Problem 5-4:** add the hypothesis that $\dim M > 1$.

(5/27/17) **Page 158, second sentence:** Replace this sentence by "More generally, suppose K is a finite Euclidean simplicial complex and w is a point in $\mathbb{R}^n$ such that each ray starting at w intersects $|K|$ in at most one point."

(4/12/20) **Page 158, Problem 5-18(b):** In the hint, change "simplex" to "cell."

(11/7/19) **Page 165, Example 6.7:** After the second sentence, add "(The disks should be chosen so that their closures are disjoint.)"

(4/12/20) **Page 167, line 5 from the bottom:** Insert "the" before "sum."

(9/16/11) **Page 172, first paragraph, next-to-last line:** Change $P'_1 \amalg Q$ to $P_1 \amalg Q$.

(9/16/11) **Page 176, Fig. 6.21:** The label b near the lower right should be c, and the label w near the middle of the right-hand side should be x.

(5/20/18) **Page 180, Proposition 6.20:** In the statement of the proposition, change "compact surface" to "connected compact surface." Then in the second sentence of the proof, change both occurrences of "surface" to "connected compact surface."

(11/5/17) **Page 181, first full paragraph:** Replace the sentence starting with "However" by "However, we will prove in Chapter 10 that a compact surface cannot have both an oriented presentation and a nonoriented one."

(2/26/18) **Page 181, Problem 6-4:** Replace the first sentence by "Suppose M is a compact 2-manifold that contains a subset $B \subseteq M$ that is homeomorphic to the Möbius band, and whose interior is homeomorphic to the Möbius band minus its boundary."

(9/16/11) **Page 190, line 3 from the bottom:** Change $\Phi_g(f)$ to $\Phi_g[f]$.

(1/20/11) **Page 193, proof of Proposition 7.16, second paragraph, line 2:** Change "$H_1 = f$" to "$H_1 = \widetilde{f}$."

(12/8/21) **Page 195, displayed equation:** Replace the last "$<$" sign by "$\le$."

(8/3/18) **Page 201, Corollary 7.38:** This corollary should be moved after the statement of Theorem 7.40.

(11/25/12) **Page 211, line 6:** Delete redundant "each."

(7/9/15) **Page 215, Problem 7-9:** Change "connected" to "path-connected."

(5/31/16) **Page 221, Theorem 8.4:** Remark: This theorem is true without the assumption that B is locally connected, and the proof is not really any more difficult; see, for example, the proof of Theorem 1.7 in [Hat02].

(7/22/19) **Page 222, first paragraph:** Change $\{J_1, \dots, J_k\}$ to $\{J_1, \dots, J_m\}$.

(1/20/11) **Page 224, two lines above the subheading:** Change $\widetilde{f}_0(1)$ to $\widetilde{f}_1(0)$.

(1/20/11) **Page 228, displayed equations (8.4):** Replace these equations by

$$\begin{aligned}\deg\varphi &= \deg(\rho_\varphi \circ \varphi)_*,\\ \deg\psi &= \deg(\rho_\psi \circ \psi)_*.\end{aligned} \tag{8.4}$$

(7/13/15) **Page 230, Problem 8-5:** Replace the last sentence of the hint by the following: "Prove that $p_\varepsilon|_{\mathbb{S}^1}$ and $p_n(z) = z^n$ are homotopic as maps from $\mathbb{S}^1$ to $\mathbb{C} \smallsetminus \{0\}$. If p has no zeros, use degree theory to derive a contradiction."

(7/13/15) **Page 231, Problem 8-10(c):** Change "index of V around the loop ω" to "winding number of V around the loop ω."

(9/16/11) **Page 239, fourth line below the section heading:** Change "generated by G" to "generated by S."

(11/29/19) **Page 241, middle of the page:** Change the definition of ***group presentation*** as follows: "We define a ***group presentation*** to be an ordered pair, denoted by $\langle S|R\rangle$, where S is an arbitrary set and R is a set of words formed from the elements of S."

(11/29/19) **Page 241, just below the last displayed equation:** Replace "where $\overline{R}$ is the ***normal closure of R in $F(S)$***" by "where now we interpret R as a set of elements of the free group $F(S)$, and $\overline{R}$ is the ***normal closure of R in $F(S)$***."

(7/28/16) **Page 244, fourth line below the section heading:** Change $n \in \mathbb{Z}$ to $n \in \mathbb{N}$.

(7/28/16) **Page 247, Example 9.22, last line:** The formula for G_{tor} should be $G_{\text{tor}} = \{0\} \times \mathbb{Z}/k_1 \times \dots \times \mathbb{Z}/k_m$.

(12/3/19) **Page 249, Problem 9-4(b):** Change "a subset of the free group $F(S_i)$" to "a set of words in the elements of S_i."

(12/3/19) **Page 249, Problem 9-5:** Change "subsets of the free group $F(S)$" to "sets of words in the elements of S."

(11/28/17) **Page 252, just above diagram (10.2):** Change "the following diagram commutes" to "the right half of the following diagram commutes."

(7/29/19) **Page 256, statement of Theorem 10.7:** Change "spaces" to "path-connected spaces."

(12/1/20) **Page 257, Example 10.8:** In the first line of the example, and in the three lines immediately above it, change "proposition" to "theorem" (three times).

(7/29/19) **Page 257, last paragraph, second sentence:** Change that sentence to read "If two or more edges are incident with the same two vertices, or if two or more self-loops are incident with the same vertex, they are called ***multiple edges***.

(12/7/20) **Page 260, proof of Theorem 10.12, second paragraph, first line:** Change Γ to $\pi_1(\Gamma, v)$.

(12/7/20) **Page 261, last paragraph of the proof, fourth line from the bottom:** Change two equalities to isomorphisms: "$\pi_1(V, v) \cong F([f_1], \dots, [f_n])$ and $\pi_1(U, v) \cong F([f_{n+1}])$."

(9/16/11) **Page 263, line 2:** Change $\widetilde{U} \cap \widetilde{V}$ to $q(D \smallsetminus \{z\})$.

(8/2/13) **Page 268, lines 2 & 3:** Change "preceding corollary" to "preceding theorem."

(11/5/17) **Page 268, statement of Corollary 10.24:** Change the statement to "*A compact surface cannot have both an oriented presentation and a nonoriented one.*"

(5/23/11) **Page 269, line below equation (10.7):** Insert missing comma after "surjective."

(10/3/20) **Page 271, line 3:** Replace the phrase "the endpoints of the paths a_i in this product are of the form i/n" by "the paths a_i in this product are defined on subintervals whose endpoints are integral multiples of $1/n$."

(7/8/14) **Page 275, Problem 10-21(c):** Delete "with nonempty intersection."

(8/27/18) **Page 278, second line below the heading:** Before "disjoint union," insert "nonempty."

(7/29/19) **Page 279, second line:** Change "Theorem 4.15" to "Proposition 4.13."

(5/31/16) **Page 282, Theorem 11.13:** Remark: This theorem, like Theorem 8.4, is true without the assumption that B is locally connected.

(5/17/12) **Page 302, Problem 11-5, first line:** Change "dimension n" to "dimension $n \geq 2$."

(11/6/19) **Page 303, Problem 11-9:** Add the hypothesis that the spaces are nonempty.

(12/10/15) **Page 303, Problem 11-12(c):** Change "$(1,0)$ or $(-1,0)$" to "1 or -1" [to be consistent with the complex notation used elsewhere for $\mathbb{S}^1$].

(5/17/12) **Page 305, Problem 11-20:** At the end of the problem, add: "For the counterexample, you may use without proof the fact that $\mathbb{S}^2$ is not contractible. (This follows, for example, from Corollary 13.11 and Theorem 13.23.)"

(2/25/18) **Page 312, last sentence of the paragraph after Exercise 12.13:** Allen Hatcher's name is misspelled.

(7/8/14) **Page 315, paragraph above the displayed diagram:** After "Q is a normal covering map," insert "and $\widehat{H} = \operatorname{Aut}_Q(E)$."

(7/8/14) **Page 315, just below the displayed diagram:** Replace the last two paragraphs on page 315 and the first (partial) paragraph on page 316 with the following:

We have to show that $\widehat{q}$ is a covering map. Let $x \in X$ be arbitrary, and let U be a neighborhood of x that is evenly covered by q. We will show that U is also evenly covered by $\widehat{q}$. Given a component U_i of $q^{-1}(U)$, let $\widehat{U}_i = Q(U_i) \subseteq \widehat{E}$; then $\widehat{U}_i$ is connected, and it is open in $\widehat{E}$ because Q is an open map (Proposition 11.1). Suppose $\widehat{U}_i = Q(U_i)$ and $\widehat{U}_j = Q(U_j)$ are any two such sets. If they have a point $\widehat{e}$ in common, then $\widehat{e} = Q(e_i) = Q(e_j)$ for some $e_i \in U_i$ and $e_j \in U_j$. Since Q identifies points of E if and only if they are in the same $\widehat{H}$-orbit, there is some $\varphi \in \widehat{H}$ such that $e_j = \varphi(e_i)$. Then $\varphi(U_i) = U_j$ by Proposition 12.1(c), so $Q(U_i) = Q \circ \varphi(U_i) = Q(U_j)$. This shows that any such sets $\widehat{U}_i, \widehat{U}_j$ are either disjoint or equal. Since Q is surjective, $\widehat{q}^{-1}(U)$ is equal to the disjoint union of the connected open sets $\widehat{U}_i$ as U_i ranges over the components of $q^{-1}(U)$.

It remains only to show that for any such set $\widehat{U}_i$, the restricted map $\widehat{q}\colon \widehat{U}_i \to U$ is a homeomorphism. The following diagram commutes:

$$\begin{tikzcd} U_i \arrow[d, "q"'] \arrow[dr, "Q"] & \\ U. & \widehat{U}_i \arrow[l, "\widehat{q}"] \end{tikzcd} \tag{12.3}$$

Since $q = \widehat{q} \circ Q$ is injective on U_i, so is Q; and $Q\colon U_i \to \widehat{U}_i$ is surjective by definition. Because Q is an open map, it follows that $Q\colon U_i \to \widehat{U}_i$ is a homeomorphism. Since q and Q are homeomorphisms in (12.3), so is $\widehat{q}$.

(9/27/11) **Page 318, statement of Proposition 12.21, second line:** Insert "*on*" after "*acting*."

(12/9/19) **Page 320, paragraph after the proof of Prop. 12.24, first line:** Before "locally," insert "nonempty."

(9/23/14) **Page 321, line 4:** Change $E \times E$ to E.

(9/27/11) **Page 329, paragraph just below the diagram:** Change every occurrence of $\widetilde{p}$ to $\widetilde{q}$ (five times).

(6/26/22) **Page 329, last paragraph, third sentence:** Change "The map $G \times P \to \mathbb{B}^2$" to "The map $\widetilde{\delta}\colon G \times P \to \mathbb{B}^2$."

(9/27/11) **Page 330, just below the bulleted list:** Change $\widetilde{p}$ to $\widetilde{q}$.

(9/27/11) **Page 332, first full paragraph, second line:** Change $\widetilde{p}$ to $\widetilde{q}$.

(9/27/11) **Page 332, second full paragraph, lines 6 and 7:** Change $\widetilde{p}$ to $\widetilde{q}$ (twice).

(9/16/14) **Page 335, Problem 12-10:** Interchange the definitions of G and H in the sixth and seventh lines. (Otherwise, part (c) is false as stated.)

(10/12/14) **Page 337, Problem 12-19:** Replace the first sentence of the problem with the following: "Suppose we are given a continuous action of a metrizable topological group (e.g., a discrete group) G on a first countable Hausdorff space E."

(7/22/19) **Page 349, line 3:** Change Δ_p to Δ_{p+1}.

(9/27/11) **Page 352, lines 3 and 4:** Change c_p to c_q (twice), and change p to q (twice).

(7/22/19) **Page 352, next-to-last line:** Change c_p to c_q (twice), and change p to q (once).

(12/15/17) **Page 354, paragraph above the last display:** Insert "of some reparametrization" after "extension of the circle representative."

(3/16/21) **Page 355, commutative diagram near the bottom of the page:** Change the period after X to a comma.

(7/22/19) **Page 360, proof of Lemma 13.20:** In the second line of the displayed equation, change $F_{i,p}$ to $F_{i,p+1}$.

(7/22/19) **Page 361, first line of text:** Change "$\in \mathbb{R}^n$" to "$\subseteq \mathbb{R}^n$."

(4/1/21) **Page 369, line above Proposition 13.33:** Delete spurious "and."

(10/8/15) **Page 370, line 5 from the bottom:** Change "It follows ..." to "Assuming X is path-connected, it follows ...."

(10/8/15) **Page 371, at the end of the first (partial) paragraph:** Insert "If X is not path-connected, just apply this argument to the path component containing the image of φ, and use Proposition 13.5."

(9/26/17) **Page 371, statement of Theorem 13.34(e):** Change "dimension n" to "dimension $n \geq 2$," and change "the zero map" to "not injective."

(4/1/21) **Pages 371–372, proof of Theorem 13.34:** Change "Theorem 13.33" to "Proposition 3.33" (five times).

(9/26/17) **Page 372, proof of Theorem 13.34, last paragraph:** Change "if $\varphi_* = 0$" to "if φ_* is injective."

(9/26/17) **Page 372, Example 13.35(b), last line:** Change "the zero map" to "noninjective."

(9/29/17) **Page 372, Example 13.35(c):** Replace the last sentence by "The image of φ_* is the infinite cyclic group generated by $\gamma\left(\alpha_1^2 \dots \alpha_n^2\right)$, so φ_* is injective and $H_2(M) = 0$."

(9/26/19) **Page 399, next-to-last line:** Change $x \in X$ to $x \in M_1$.

(12/26/18) **Page 401, line 4 from the bottom:** Change "subset" to "nonempty subset."

(10/7/19) **Page 402, Exercise C.1:** Change "any subset" to "any nonempty subset."

(6/6/18) **Page 411, near the middle of the page:** The index entry for $\overline{R}$ should read "(normal closure of a subset)."

(2/25/18) **Page 422:** The index entry for "Hatcher, Allen" is misspelled.