Toric Varieties
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This errata sheet is organized by which printing of the book you have. The printing can be found by looking at the string of digits 10 9 8 . . . at the bottom of the copyright page: the last digit that appears in this decreasing string indicates the printing.

Errata for the second printing as of May 13, 2013

Page 47, line 3 of Exercise 1.3.11: “a + b ≡ 0 mod d” should be “a − b ≡ 0 mod d”

Page 66, line −4: “Let uF denote” should be “Let uF ∈ N denote”

Page 121, first display: The union on the right should be ∪ τ⪯σ′ O(σ)

Page 176, Exercise 4.1.5: Delete the entire exercise and replace it with the following:

4.1.5. The weighted projective space \( \mathbb{P}(q_0, \ldots, q_n) \), gcd(\( q_0, \ldots, q_n \)) = 1, is built from a fan in \( N = \mathbb{Z}^{n+1}/\mathbb{Z}(q_0, \ldots, q_n) \). Let \( u_i \in N \) be the image of \( e_i \in \mathbb{Z}^{n+1} \). The dual lattice is

\[
M = \{ (a_0, \ldots, a_n) \in \mathbb{Z}^{n+1} \mid a_0 q_0 + \cdots + a_n q_n = 0 \}.
\]

Also assume that gcd(\( q_0, \ldots, q_i, \ldots, q_n \)) = 1 for \( i = 0, \ldots, n \).

(a) Prove that the \( u_i \) are the primitive ray generators of the fan giving \( \mathbb{P}(q_0, \ldots, q_n) \).

(b) Prove that Cl(\( \mathbb{P}(q_0, \ldots, q_n) \)) \iso \mathbb{Z}. Hint: Show that the maps

\[
\begin{align*}
M & \longrightarrow \mathbb{Z}^{n+1} : m \longmapsto (\langle m, u_0 \rangle, \ldots, \langle m, u_n \rangle) \\
\mathbb{Z}^{n+1} & \longrightarrow \mathbb{Z} : (a_0, \ldots, a_n) \longmapsto a_0 q_0 + \cdots + a_n q_n
\end{align*}
\]

give an exact sequence

\[
0 \longrightarrow M \longrightarrow \mathbb{Z}^{n+1} \longrightarrow \mathbb{Z} \longrightarrow 0.
\]

Page 188, Exercise 4.2.11: Delete the entire exercise and replace it with the following:

4.2.11. In Exercise 4.1.5, you showed that the weighted projective space \( \mathbb{P}(q_0, \ldots, q_n) \) has class group Cl(\( \mathbb{P}(q_0, \ldots, q_n) \)) \iso \mathbb{Z} \) when gcd(\( q_0, \ldots, q_i, \ldots, q_n \)) = 1 for all \( i \). Prove that Pic(\( \mathbb{P}(q_0, \ldots, q_n) \)) \subseteq Cl(\( \mathbb{P}(q_0, \ldots, q_n) \)) maps to \( m \mathbb{Z} \subseteq \mathbb{Z} \), where \( m = \text{lcm}(q_0, \ldots, q_n) \). Hint: Show that \( \sum_{i=0}^n b_i D_i \) generates the class group, where \( \sum_{i=0}^n b_i q_i = 1 \). Also note that \( m \in M \) lies in \( M \) if and only if \( \langle m, u_i \rangle \in \mathbb{Z} \) for all \( i \), where the \( u_i \) are from Exercise 4.1.5.

Page 196, line 3: “elements of G” should be “elements of \( R^G \)”

Page 201, lines 5 and 6: “if its maximal connected solvable subgroup is a torus” should be “if the identity component of its maximal normal solvable subgroup is a torus”.

Page 202, line 7 of the proof of Proposition 5.0.11: “closed in \( \mathbb{C}^4 \)” should be “closed in \( X \)”

Page 213, Example 5.1.14: Delete the first paragraph of the example and replace it with the following:
Example 5.1.14. Fix positive integers \( q_0, \ldots, q_n \) with \( \gcd(q_0, \ldots, q_i, \ldots, q_n) = 1 \) for all \( i \) and let \( N = \mathbb{Z}^{n+1}/\mathbb{Z}(q_0, \ldots, q_n) \). By Exercise 4.1.5, the images of the standard basis in \( \mathbb{Z}^{n+1} \) give primitive elements \( u_i \in N \) satisfying \( q_0 u_0 + \cdots + q_n u_n = 0 \). Let \( \Sigma \) be the fan consisting of all cones generated by proper subsets of \( \{ u_0, \ldots, u_n \} \).

Page 218, line 2 of Exercise 5.1.6: “\( t = \prod_{i=0}^{n} t^a_i \)” should be “\( t = \prod_{i=0}^{n} t^b_i \)”.

Page 253, line 12 of the proof of Theorem 6.0.18: “\( f_i f \in O_X(D)(U_i) \)” should be “\( f_i f \in O_X(U_i) \)”.

Page 253, line 16 of the proof of Theorem 6.0.18: “\( s_i \in O_X(D)(U_i) \)” should be “\( s_i \in O_X(U_i) \)”.

Page 256, line 6 of the proof of Proposition 6.0.22: “\( D' \neq Z_0 \)” should be “\( D' \neq D_0 \)”.

Page 260, line 1: “sections of \( U_i \times \mathbb{C} \to \mathbb{C} \)” should be “sections of \( U_i \times \mathbb{C} \to U_i \)”.

Page 269, line −7: “\( \phi_{D_P} = \phi_{\mathcal{O}_X(D_P), W} \to \mathbb{P}^{s-1} \)” should be “\( \phi_{D_P} = \phi_{\mathcal{O}_X(D_P), W} : X_P \to \mathbb{P}^{s-1} \)”.

Page 270, line 6: “\( \text{div}(s_i)_0 \)” should be “\( \text{div}_0(s_i) \)”.

Page 274, line −6: “be a Cartier divisor” should be “be an ample divisor”.

Page 278, line −6: “Some of the most interesting” should be “Some of the most interesting”.

Page 358, line 2 of §8.1: “sheaves \( \omega^1_{X_{\Sigma}} \)” should be “sheaves \( \Omega^1_{X_{\Sigma}} \)”.

Page 485, part (b) of Exercise 10.2.13: “in general” should be “when \( \gcd(q_1, q_2) = 1 \)”.

Page 683, display (14.1.4): “\( S_{\ell d} \)” should be “\( R_{\ell d} \)”.

Page 683, two lines below display (14.1.4): “to global section” should be “to a global section”.

Page 686, line 3 of proof of Lemma 14.2.1: “that Laurent monomial” should be “that the Laurent monomial”.

Page 693, line 2 of Example 14.2.14: “\( \mathbb{C}^\Sigma(1) \)” should be “\( \mathbb{C}^{\Sigma(1)} \)”.

Page 841, index entry for weighted projective space: Add pages 213, 225, 380, 384, and 485 to the list.

Errata for the first printing as of November 20, 2011

The errata in the first printing of the book include the errata for the second printing (listed above) together with the following additional errata, all of which were corrected in the second printing.

Page 70, line −1: Delete this line and replace it with the following:

“we also have the following result about the Hilbert basis of \( C(P) \cap (M \times \mathbb{Z}) \).

Page 71, lines 1–7: Delete these lines and replace them with the following:

Lemma 2.2.16. Let \( P \subseteq M_\mathbb{R} \simeq \mathbb{R}^n \) be a lattice polytope of dimension \( n \geq 2 \) and let \( k_0 \) be the maximum height of an element of the Hilbert basis of \( C(P) \). Then

\[ k_0 \leq n - 1. \]
Proof. This follows easily from (2.2.3). □

The Hilbert basis of the simplex $P$ of Example 2.2.15 has maximum height 2 by Lemma 2.2.16. The paper [187] gives a version of Lemma 2.2.16 that applies to Hilbert bases of more general cones. See also Exercise 2.2.9.

Page 74, Exercise 2.2.9: Delete the entire exercise and replace it with the following:

2.2.9. Let $\text{Cone}(\mathcal{A}) \subseteq M_\mathbb{R} \simeq \mathbb{R}^n$ be a full dimensional strongly convex cone and let $\mathcal{H}$ be the Hilbert basis of $\text{Cone}(\mathcal{A}) \cap M$. Write $\mathcal{A} = \{m_1, \ldots, m_s\} \subseteq M$, where each $m_i$ is nonzero and primitive. Following [187], the height of $m \in \text{Cone}(\mathcal{A}) \cap M$ is defined to be

$$h(m) = \max \left( \sum_{j=1}^n \lambda_j \mid m = \sum_{j=1}^n \lambda_j m_{i_j}, m_{i_1}, \ldots, m_{i_n} \text{ linearly independent} \right).$$

The main result of [187] states that if $n \geq 3$, then $h(m) < n - 1$ for all $m \in \mathcal{H}$.

(a) Let $C(P) \subseteq M_\mathbb{R} \times \mathbb{R}$ be the cone from Lemma 2.2.16. Prove that $h((m,k)) = k$ for all $(m,k) \in \text{Cone}(P) \cap M \times \mathbb{Z}$.

(b) Explain how Lemma 2.2.16 follows from the result of [187].

Page 113, line −3: “(that is, $X_\Sigma$ has)” should be “(i.e., $X_\Sigma$ has)”

Page 113, line −2: Add the following new sentence at the end of the existing line: “We say that $X_\Sigma$ is simplicial in this case.”

Page 115, line −4: “the relative interior of” should be “the relative interior of”

Page 136, line 2 of Exercise 3.3.5: “with the property that” should be “such that $\overline{\phi}(\tilde{\sigma} \cap N) = \sigma' \cap N'$ and”

Page 137, line 3 of part (b) of Exercise 3.3.7: “$\overline{N'}$” should be “$\overline{\phi}^{-1}(N'')$”

Page 138, line 1 of Exercise 3.3.12: “Consider the fan” should be “Consider the complete fan”

Page 184, line −10: “$- \sum_\rho \varphi_D(u_\rho)D_\rho$” should be “$- \sum_\rho \varphi(u_\rho)D_\rho$”

Page 187, part (a) of Exercise 4.2.7: “$O(\sigma) =$” should be “$V(\sigma) = \overline{O(\sigma)} =$”

Page 188, line 2 of Exercise 4.2.9: “instead use” should be “use”

Page 188, line 3 of Exercise 4.2.9: “with $a > 1$” should be “with $a$ odd”

Page 224, line −1: “where $\sigma_1, \sigma_2 \in \Sigma$ are as in Example 5.1.16” should be “where $\sigma_i = \text{Cone}(u_0, u_i)$ for $u_0, u_1, u_2$ as in Example 5.1.16”

Page 226, line 2 of Exercise 5.2.6: Add the new sentence: “Let $\sigma_1, \sigma_2$ be as in Example 5.2.11.”

Page 228, line 2 of proof of Lemma 5.3.5: “for all $\rho$” should be “for all $\rho \in \sigma(1)$”

Page 249, third display: “$\text{Hom}_{\mathcal{O}_X(U)}(\mathcal{F}(U), \mathcal{G}(U))$” should be “$\text{Hom}_{\mathcal{O}_U}(\mathcal{F}|_U, \mathcal{G}|_U)$”

Page 276, line 1 of Exercise 6.1.2: “(b) $\Rightarrow$ (d)” should be “(b) $\Rightarrow$ (f)”

Page 309, Exercise 6.4.2: In two places, “Example 6.4.2” should be “Example 6.4.6”

Page 331, line −1: “$k \geq n$” should be “$k \geq n - 1$”

Page 343, line 1: “rays in $P$” should be “rays in $Q$”

Page 379, lines 2 and 3 of Exercise 8.2.14: Replace the sentence beginning “In the discussion” with “Let $P \subseteq M_\mathbb{R}$ be a lattice polytope containing the origin as an interior point. In the discussion of the algebra (8.2.5), we saw that $P$ gives the cone”
Page 382, part (a) of Lemma 8.3.6: “common edge” should be “common facet”

Page 384, line −14: “most more recent” should be “most recent”

Page 385, line 4: “contains exactly two vertices” should be “contains exactly two lattice points”

Page 398, line 3 of §9.1: “torus-invariant $\mathbb{Q}$-Cartier divisors” should be “torus-invariant Weil divisors”

Page 398, line −11: “torus-invariant Cartier divisor” should be “torus-invariant Weil divisor”

Page 410, line 10: “$\langle m, v \rangle < \varphi_D(u)$” should be “$\langle m, v \rangle < \varphi_D(v)$”

Page 420, line 1 of part (b) of Exercise 9.2.12: “$\sigma$ is contained” should be “$\Delta_\sigma$ is contained”

Page 450, line −7: “$\text{Ext}^{p+1}(S/B(\Sigma)[^q], S)$” should be “$\text{Ext}^{p+1}(S/B(\Sigma)[^q], S)_\alpha$”

Page 477, part (c) of Theorem 10.2.12: “(resp. $\Theta_0$)” and “(resp. even)” should be “(resp. $\Theta_0$)” and “(resp. even)”

Page 496, line −10: “$b_1 > 2$” should be “$b_1 \geq 2$”

Page 496, line −9: “$b_1 < -2$” should be “$b_1 \leq -2$”

Page 501, line 2 of Exercise 10.4.2: “$b_1 < 2$” should be “$b_1 \leq 2$”

Page 529, line −5: “dimension $\geq 3$” should be “dimension $\geq 4$”

Page 705, fourth bullet of Example 14.3.8: “$(\mathbb{C}^3)^{ss}$” and “$(\mathbb{C}^3)^s$” should be “$(\mathbb{C}^3)^{ss\chi}$” and “$(\mathbb{C}^3)^{s\chi}$”

Page 797, bottom: Add the following new paragraph:

New packages and updates to old packages (including new URLs) can be found at http://www.cs.amherst.edu/~dac/toric.html.

Page 817, reference [2]: “K. Matsuk” should be “K. Matsuki”

Page 819, reference [40]: “vectors bundles” should be “vector bundles”

Page 819, reference [56]: “W. Brun” should be “W. Bruns”

Page 839, index entry for simplicial toric variety: “180” should be “113, 180”