Errata for
Quantum Computing for Computer Scientists
by N.S. Yanofsky and M.A. Mannucci
Most of these errors were found by
Manuel Silva

(Unless otherwise stated, the errors were pointed out by Manuel Silva in January of 2009.)

Errata for Chapter 1

1. Page. xv. Section ACKNOLWEDGMENTS should be ACKNOWLEDGEMENTS. Alex Sverdlov, 10/26/2008.

2. Page 325: Equation (B.3) should be

$$\begin{aligned} |c_1||c_2| &= \sqrt{a_1^2+b_1^2}\sqrt{a_2^2+b_2^2} = \sqrt{(a_1^2+b_1^2)(a_2^2+b_2^2)} \\ &= \sqrt{a_1^2a_2^2+b_1^2a_2^2+b_1^2b_2^2+a_1^2b_2^2} = \sqrt{(\boldsymbol{a_1a_2-b_1b_2})^2+(a_1b_2+a_2b_1)^2} \\ &= |(\boldsymbol{a_1a_2-b_1b_2}, a_1b_2+a_2b_1)| = |c_1c_2|. \end{aligned}$$

Errata for Chapter 2

1. Page 51: In the third line below (2.88), "any matrix" should be "any **vector**".

2. Page 54: Equations (2.103) and (2.104) are wrong, because they are not compatible with (2.107). The correct equations are

$$\langle \boldsymbol{c \cdot V_1, V_2} \rangle = \bar{\boldsymbol{c}} \times \langle \boldsymbol{V_1, V_2} \rangle,$$

$$\langle \boldsymbol{V_1, c \cdot V_2} \rangle = \boldsymbol{c} \times \langle \boldsymbol{V_1, V_2} \rangle.$$

3. Page 61: (Typo) In the second line of Definition 2.5.1, "with $\mathbb{C}^n$" should be "**in** $\mathbb{C}^n$".

4. Page 63: Equation (2.142) should be modified to

$$\boldsymbol{c\langle V, V\rangle = \langle V, cV\rangle = \langle V, AV\rangle = \langle AV, V\rangle = \langle cV, V\rangle = \bar{c}\langle V, V\rangle.}$$

Additionally, the last sentence of the third line below (2.142) should be "**Because V is** nonzero, $c = \bar{c}$ and hence must be real." The value $c = 0$ can be an eigenvalue, of course.

5. Page 64: Equation (2.144) should be

$$\begin{aligned} \boldsymbol{c_2\langle V_1, V_2\rangle} &= \boldsymbol{\langle V_1, c_2 V_2\rangle = \langle V_1, AV_2\rangle = \langle AV_1, V_2\rangle} \\ &= \boldsymbol{\langle c_1 V_1, V_2\rangle = \bar{c}_1\langle V_1, V_2\rangle = c_1\langle V_1, V_2\rangle.} \end{aligned}$$

Additionally, in the third line below (2.144), "H" should be "$\boldsymbol{A}$".

6. Page 65: (Typo) In the third line below (2.150), "face" should be "**fact**".

7. Page 71: In the second and third lines, "**tensor product**" would be better than simply "tensor".

8. Page 328: (Typos) In the answer 2.2.5, three 'i should be $\boldsymbol{i}$.

9. Page 329: (Typo) In the answer 2.4.3, a 3' should be **3**.

10. Page 330: The last sentence of the first two lines should be
"The right-hand side is $\boldsymbol{Trace(A^T * C) = 7}$ added to $\boldsymbol{Trace(B^T * C) = -2}$ for a sum of 5."
Finally, in Equation (B.40), "$[z, y, z]^T$" should be "$\boldsymbol{[x, y, z]^T}$".

11. Page 331 (Typo) At the end of the fifth line of Equation (B.43), "k/p'," should be "$\boldsymbol{k/p'}$".

Errata for Chapter 3

1. Pages 83 and 84: Exercises 3.2.4 and 3.2.5 should be placed just before Example 3.2.2, that is, after the explanation about (3.26).

2. Page 90: The statement of note 6 is false in general.

3. Page 95: (Typos) In Eq. (3.52), three entries of the matrix are wrong. The correct matrix is

$$P^2 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{-1+i}{\sqrt{12}} & \frac{-1+i}{\sqrt{6}} & 0 & 1 & 0 & 0 & 0 & 0 \\ \frac{-1-i}{\sqrt{12}} & \frac{-1-i}{\sqrt{6}} & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & \boldsymbol{\frac{1-i}{\sqrt{6}}} & \boldsymbol{\frac{-1+i}{\sqrt{6}}} & 0 & 0 & 1 & 0 & 0 \\ \frac{-1-i}{\sqrt{12}} & 0 & \frac{-1-i}{\sqrt{6}} & 0 & 0 & 0 & 1 & 0 \\ \boldsymbol{\frac{1-i}{\sqrt{12}}} & 0 & \frac{1-i}{\sqrt{6}} & 0 & 0 & 0 & 0 & 1 \end{bmatrix}.$$

4. Page 335: The answer of Ex. 3.2.2 corresponds only to part (a). By putting $\sum_{\boldsymbol{i}} \boldsymbol{X}[\boldsymbol{i}] = \boldsymbol{x}$ in the first line and $\boldsymbol{x}$ instead of 1 at the end of Eq. (B.58) the general answer is given.

5. Page 336: The answer of Ex. 3.3.3 is not correct. Indeed, the first equality in (B.67) suggests that $(U * X)[j] = \sum_k U[j,k] \times X[j]$ which is wrong; the correct equation is $(U * X)[j] = \sum_k U[j,k] \times X[k]$. But if we change $X[j]$ by $X[k]$, the second equality in (B.67) requires a better (nontrivial) justification. Simplify the proof noting that if $\sum_j |X[j]|^2 = \langle X, X\rangle = x$, then

$$\sum_j |(U * X)[j]|^2 = \langle UX, UX\rangle = \langle X, X\rangle = x$$

where it is used Eq. (2.150).

Errata for Chapter 4

1. Page 106: In the last sentence of footnote 5, "with intensity c_i" should be "with **amplitude** c_i".

2. Page 107: In Equation (4.9), "0.052624" should be "0.0526**32**".

3. Page 108: In Exercise 4.1.1, the question is about the likelihood of finding the particle at position x_3. But in the answer (see page 337) it is calculated $p(x_3)$ and $p(x_4)$.

4. Page 109: In Equation (4.21), "0.41714" should be "0.4**7140**".

5. Page 112: In Equation (4.32), "$\langle\psi|\psi'\rangle$" should be "$\boldsymbol{\langle\psi'|\psi\rangle}$".

6. Page 114: In the third line below Exercise 4.1.10, it is used the expression "hermitian product" that was not defined; it would be preferable to use "**inner** product" as in the rest of the text.

7. Page 116: Equations (4.42) and (4.43) should be rewritten. The correct equations are

$$\boldsymbol{P(|x_i\rangle) = x_i|x_i\rangle.}$$

$$\boldsymbol{P(|\psi\rangle) = P\left(\sum c_i|x_i\rangle\right) = \sum x_i c_i|x_i\rangle.}$$

8. Page 117: (Typo) In the last line of footnote 10, "$\psi\rangle$" should be "$|\psi\rangle$".

9. Page 120: The statement of Exercise 4.2.8 is wrong. The commutator of two hermitian matrices is not hermitian. It is actually anti-hermitian: if $A^\dagger = A$ and $B^\dagger = B$, we have

$$[A,B]^\dagger = (AB-BA)^\dagger = (AB)^\dagger-(BA)^\dagger = B^\dagger A^\dagger - A^\dagger B^\dagger = BA-AB = -[A,B].$$

This is clearly visible in Equation (4.57): the commutator $[S_x, S_y]$, for example, is equal to $2iS_z$. The operator S_z is hermitian, but the operator $2iS_z$ is anti-hermitian because $2i$ is not a real number (see Exercises 4.2.3 and 4.2.4).

10. Page 121: Equation (4.67) should be

$$|\psi\rangle = \left[\frac{\sqrt{2}}{2}, -\frac{\sqrt{2}}{2}\right]^T.$$

11. Page 123: (Typo) In Equation (4.73), "$\langle|\psi\rangle$" should be "$|\psi\rangle$". Additionally, in Equation (4.74), the term "$\langle\Omega\rangle_\psi$" should be "$\langle\Omega\rangle_\psi \boldsymbol{I}$".

12. Page 124: In Equation (4.77), the term "$\langle\Omega\rangle_\psi$" should be "$\langle\Omega\rangle_\psi \boldsymbol{I}$".
Additionally, Equation (4.79) has <u>two</u> errors. The correct equation is

$$\langle(\Delta_\psi(\Omega))(\Delta_\psi(\Omega))\rangle_\psi = \left[\tfrac{\sqrt{2}}{2} \quad -\tfrac{\sqrt{2}}{2}i\right] \begin{bmatrix} 3.25 & 2i \\ -2i & 1.25 \end{bmatrix} \begin{bmatrix} \frac{\sqrt{2}}{2} \\ \frac{\sqrt{2}}{2}\boldsymbol{i} \end{bmatrix} = 0.25.$$

13. Page 126: In Example 4.3.1, the normalized eigenvectors should be

$$|e_1\rangle = [-0.92\mathbf{4}i, -0.38\mathbf{3}]^T \qquad \text{and} \qquad |e_2\rangle = [-0.38\mathbf{3}i, 0.92\mathbf{4}]^T.$$

Additionally, it would be better to write the state $|\psi\rangle$ as $|\psi\rangle = \frac{\sqrt{2}}{2}[1,1]^T$ (that is, normalized). [If not, Equation (4.84) in Page 127 has to be modified dividing by $\langle\psi|\psi\rangle$. The same on the first line below (4.85).]

14. Page 127: In the second line, "orthogonal" should be "**orthonormal**".
Additionally (typo), in the second line below (4.82), "$\langle\Omega\rangle_v$" should be "$\langle\Omega\rangle_{\boldsymbol{\psi}}$".

15. Page 127: In Equation (4.84), "$\langle\psi|e_1\rangle$" and "$\langle\psi|e_2\rangle$" should be "$\boldsymbol{\langle e_1|\psi\rangle}$" and "$\boldsymbol{\langle e_2|\psi\rangle}$", respectively. That equation is not wrong due to the square of the modulus, but in this way it is clearly visible the transition amplitude defined in (4.32) and shown in (4.34).

16. Page 127: In Equation (4.85), "0.00" should be "0".
Additionally, in the following line, "the value we obtained" should be "the value we **could** obtain".

17. Page 128: In the first line below Figure 4.5, "planes orthogonal" should be "**directions** orthogonal". Additionally, two lines below, "specific plane" should be "specific **direction**". Finally, in the next line, "this plane or is orthogonal?" should be "this **direction** or **its** orthogonal?".

18. Page 129: (Typo) In Figure 4.6, "angels" should be "**angles**". [I have usually ignored these kind of typos; this is an exception.]

19. Page 131: In Equation (4.96), "$\hbar$" should be "$\boldsymbol{h}$". [Alternative (worse): Make the factor 2π disappear.]

20. Page 134: (Typos) Equation (4.101) has two typos: the correct equation is

$$|\psi\rangle = i|x_0\rangle \otimes |y_0\rangle + (1-i)|x_0\rangle \otimes |y_1\rangle + 2|x_1\rangle \otimes |\boldsymbol{y}_0\rangle + (-1-i)|x_1\rangle \otimes |\boldsymbol{y}_1\rangle.$$

21. Page 338: In the first two lines, "conjugate" should be "**adjoint**" (two times).

Errata for Chapter 5

1. Page 141: In the line below Equation (5.11), "$\begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix}$" should be "$\begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix}$". Additionally, in the line below Equation (5.12), "$\begin{bmatrix} \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{bmatrix}$" and "$\begin{bmatrix} -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix}$" should be "$\begin{bmatrix} \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} \end{bmatrix}$" and "$\begin{bmatrix} -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix}$", respectively.

2. Page 141: The example given in the fourth and fifth lines below (5.13) should be described in another way, because that picture (an electron moving in an orbit around the nucleus of an atom) is not satisfactory (Bohr's model was rejected a long time ago). Suggestion: "An electron **in an atom might be in one of two different energy levels** (ground state and excited state)."

3. Page 149: The logic circuit at the bottom of the page should be right after "Consider the circuit". N.S.Y. 8/30/2008.

4. Page 161: In the second line, "$0 \leq \theta < \frac{\pi}{2}$" should be "$0 \leq \theta \leq \frac{\pi}{2}$". Additionally, in the first line below Equation (5.91), "$0 \leq \phi \leq 2\pi$" can be changed to "$0 \leq \phi < 2\pi$".

5. Page 162: In Exercise 5.4.5, "after being observed" should be "**when it is** observed".

6. Page 164: In the legend of Figure 5.8, "at" could be changed to "**about**".

7. Page 168: At the end of the first sentence below (5.118), which is a question, a sign "**?**" should be placed (after "$z = 0$").

8. Page 168: 4 lines from the top "On the other hand, the no-cloning theorem says that no quantum gate[s] can mimic the fanout operation." N.S.Y. 8/30/2008.

9. Page 339: In Equation (B.83), the final "." should be omitted.

10. Page 341: The answer to Exercise 5.4.1 is not correct. Since this exercise is after Equation (5.72), it is supposed that matrices S and T are included in this exercise. And obviously $S^* \neq S$ and $T^* \neq T$. Anyway, the relevant matrix is the adjoint, not the conjugate, because each matrix has to be multiplied by its adjoint [see Equation (2.147) and the definition just before Exercise 2.2.5] to get the identity.

Errata for Chapter 6

1. Page 178: In Equation (6.41), "$-1|0\rangle$" should be "$-1|1\rangle$". See also item 36.

2. Page 180: In the sixth line below Exercise 6.2.1, "this algorithm" should be "this **problem**".

3. Page 183: In Equation (6.55), "$x_1 \oplus y_1, x_2 \oplus y_2, ..., x_n \oplus y_n$" should be "$x_0 \oplus y_0, x_1 \oplus y_1, ..., x_{n-1} \oplus y_{n-1}$".

4. Page 187: In the second line above Equation (6.82), "$\mathbf{c} = c_0 c_1 \cdots c_{n-1}$" should be "$\mathbf{c} = c_1 c_2 \cdots c_n$". This way, it is maintained the notation used in the second and third lines above Exercise 6.3.2 in page 193, and in the final part of Example 6.3.2 in page 195.

5. Page 189: In Equations (6.92) and (6.93), the denominator "2" should be "2^n" (4 times). Additionally, in the last line, "$\frac{0}{2}$" should be "$\frac{0}{2^n}$", and "$\frac{\pm 2}{2} = \pm 1$" should be "$\frac{\pm 2}{2^n} = \frac{\pm 1}{2^{n-1}}$".

6. Page 191: In Equation (6.98), "$f(\boldsymbol{x})\rangle$" should be "$|f(\boldsymbol{x})\rangle$".

7. Page 195: In the first line, "sixth" should be "**seventh**".

8. Page 195: Exercise 6.3.3 has many solutions, so should be modified. Only 5 of the $\mathbf{z}_i$ are independent, and we needed 7 to determine a unique solution $\mathbf{c} \neq \mathbf{0}$ (see item 11). Your solution was $\mathbf{c} = 10011001$ but there are other 6 non-zero solutions: 00111100, 01011010, 01100110, 10100101, 11000011 and 11111111.

9. Page 199: (Typo) In the first line of Exercise 6.4.2, "number" should be "numbers".

10. Page 202: In the paragraph below Exercise 6.4.4, "$\sqrt{2^n}$" should be "$\frac{\pi}{4}\sqrt{2^n}$" (four times).

11. Page 202: In Equation (6.135), the "0" below "**000**" should be "1".

12. Page 203: In Equations (6.136) and (6.137), the "000 001 ... 111" should be bold, as in the other Equations [(6.135), (6.141), etc.].

13. Page 204: In the second line below Equation (6.146), "measuring those numbers" should be "measuring **the corresponding states**".

14. Page 204: In the paragraph below Exercise 6.4.5, "n" should be replaced by "m" (three times), as in Page 196, to avoid confusions with the previous n and with the n used in the next paragraph.

15. Page 204: In the third line of the last paragraph of Section 6.4, "$\sqrt{\frac{2^n}{t}}$" should be "$\frac{\pi}{4}\sqrt{\frac{2^n}{t}}$" (see item 18).

16. Page 205: In the sixth line of Example 6.5.1, "2,3374" should be "23,374" (twice).

17. Page 208: In the first line above Equation (6.161), "the smallest r such that" should be "the smallest $r > 0$ such that".

18. Page 209: In Equation (6.164), "log" should be "$\log_2$" (twice), as in the second line above that equation. Additionally (typo), in the first line after Equation (6.165), "$\mathbf{y} \ominus f_{a,N}(\mathbf{x})\rangle$" should be "$\mathbf{y} \oplus f_{a,N}(\mathbf{x})\rangle$".

19. Page 211: In the first and second lines above Example 6.5.8, "when the top is measured, the bottom stays the same" should be changed to "when the **bottom are** measured, the **top stay** the same", because at that time only the bottom qubits were measured.

20. Pages 211-212: In Equation (6.177), the denominator "$\lfloor \frac{2^m}{r} \rfloor$" should be "$\sqrt{\lfloor \frac{2^m}{r} \rfloor}$" if we want that the state $|\varphi_3\rangle$ is correctly normalized. The same for the denominator "$\left[\frac{2^m}{r}\right]$" in Equation (6.178), the denominator "$\left[\frac{256}{4}\right]$" in Equation (6.179), and the denominator "$\left[\frac{2^{18}}{78}\right]$" in Equation (6.180).

21. Page 213: In Equations (6.182) and (6.183), "a_k" should be "a_j". Additionally, in the second line below Equation (6.182), "$\mathcal{V}(x_0, x_1, x_2, x_{n-1})$" should be "$\mathcal{V}(x_0, x_1, x_2, ..., x_{n-1})$".

22. Pages 213-214: In the fourth and fifth lines below Equation (6.182), "powers of the Mth roots of unity, ω_M" could be changed to "powers of one of the Mth roots of unity, ω_M^1". Additionally, in the first and second lines above Equation (6.183), and in the second line below Figure 6.7, "at the powers of the Mth root of unity" could be changed to "at the Mth roots of unity".

23. Page 214: In Equation (6.187), the last sum $\left(\sum_{i=0}^{M-1} \omega^{-i(k-j)}\right)$ should be multiplied by a factor $\frac{1}{M}$.

24. Page 217: In **Step 4**, "a^r" should be "$a^{\frac{r}{2}}$". Additionally, in the fourth line above Equation (6.203), "$U_{a,N}$" should be "$U_{f_{a,N}}$".

25. Page 341: In the answer to Exercise 6.1.6, "$+1|0\rangle$" should be "$+1|1\rangle$", "$+1|1\rangle$" should be "$+1|0\rangle$", and "$-1|1\rangle$" should be "$-1|0\rangle$". See also item 1.

26. Page 342: In the second line of the answer to Exercise 6.2.5, "constant than we will *probably* get $|0\rangle$" should be "contant**, then** we will *probably* get $|\mathbf{0}\rangle$", and in the next line, "If it is close to constant, then we will *probably* get $|1\rangle$" should be "If it is close to **balanced**, then we will ***rarely*** get $|\mathbf{0}\rangle$". Additionally, in the last line of the answer to Exercise 6.3.1, "101" should be "100" (twice).

27. Page 344: In the first line, "654" should be "160". Additionally, the third line "**Ex. 6.5.3:** The periods are 38, 20 and 11." should be "**Ex. 6.5.4:** The periods are 36, 18 and 18.". Finally, in the fourth line, "**Ex. 6.5.4:**" should be "**Ex. 6.5.7:**".

Errata for Chapter 7

1. Page 228: Equation (7.4) has five errors. The correct equation is

$$\begin{aligned} U_3 &= \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 0 \\ 0 & e^{\boldsymbol{i}\frac{\pi}{4}} \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & e^{\boldsymbol{i}\frac{\pi}{2}} \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & e^{\boldsymbol{i}\frac{\pi}{4}} \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & e^{\boldsymbol{i}\frac{\pi}{2}} \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \\ &= \begin{bmatrix} 0.70711 & 0.70711 \\ -0.70711i & 0.70711i \end{bmatrix}. \end{aligned}$$

2. Page 229: In the first line below Equation (7.7), "R_1" should be "R".

3. Page 231: Equation (7.11) has various errors. The correct equation is

$$U_f\left(c_0|0...00\rangle + c_1|0...01\rangle + \cdots + c_{2^n-1}|1...11\rangle\right)$$
$$= c_0|f(0...00)\rangle + c_1|f(0...01)\rangle + \cdots + c_{2^n-1}|f(1...11)\rangle.$$

   Note, in particular, that "2^{n-1}" was changed to "$2^n - 1$".

4. Page 232: In Exercise 7.3.3, "2^{2^n}" should be "$\mathbb{C}^{2^{2n}}$". Additionally, in the second line below that exercise, "(7.13)" should be "(7.11)". Finally, in Equation (7.16), "$f(x) \oplus y, x$" should be "$x, f(x) \oplus y$" (twice).

5. Page 233: In Equation (7.17), "c_{16}" should be "c_{15}" (twice).

6. Page 233: In the first paragraph below Equation (7.17), "Now, we apply U_f to it and get 1011. Finally, we measure the subregister given by its first two indexes, obtaining 01, as desired" should be "Now, we apply U_f to it and get **1111**. Finally, we measure the subregister given by its **last** two indexes, obtaining **11**, as desired".

7. Page 233: In Equation (7.18), the last term "$|x, 0, g(f(x)\rangle$" should be "$|x, 0, g(f(x))\rangle$".

8. Page 345: Although the final answer is correct, the answer to Ex. 7.2.3 should be rewritten. The left square on top of U is <u>not</u> the 2-by-2 identity, but the phase shift matrix R_π. It is more appropriate to write R_π instead of R_{180}, so $U = I_2 \otimes R_\pi$.

Errata for Chapter 8

1. Page 239: Beginning of Section 8.1 "Theoretical computer science deals with the question, 'What is computable?' " Clearly theoretical computer science is a much more diverse subject. N.S.Y. 8/30/2008.

2. Page 241: Paragraph 4. "These machines [are] build up to a crescendo untilĚ" N.S.Y. 8/30/2008.

3. Page 241: Footnote 2. "We have [the] adopted the convention that if the word is empty it is rejected." N.S.Y. 8/30/ 2008.

4. Page 241: In Equation (8.6), "Σ^*" should be "$(\Sigma - \{\#\})^*$", according to the first and the ninth lines of that page.

5. Page 248: At the beginning of the third paragraph, "**Exercise 8.2.1**" should be "**Example 8.2.1**". Accordingly, the symbol "■" at the end of the line above Exercise 8.2.2 should be "□".

6. Page 254: In Equation (8.45),
   $\boldsymbol{Config_X}$ should be $\boldsymbol{Config_j}$ in the first line, and
   $\boldsymbol{Config_j}$ should be $\boldsymbol{Config_i}$, $c_{j,0}$ should be $c_{i,0}$, $c_{j,1}$ should be $c_{i,1}$, $c_{j,2}$ should be $c_{i,2}$, and $c_{j,j}$ should be $c_{i,j}$ in the near-end line.

7. Page 256: (Typo) In the eleventh line, "double-split" should be "double-slit".

8. Page 257: In the fourth line, "leftmost" should be "rightmost". Additionally, in the fourth line above (8.53), "with **B**ounded error on both sides" should be "with **Z**ero error".

9. Page 259: Footnote 15. It has been shown in Bennett et al (1997). N.S.Y. 10/31/2008.

10. Page 260: In Equation (8.59), "1,024 seconds" should be "1.024 seconds".

11. Page 347: In Equation (B.108), "1,6384" should be "16,384", and "3,2768" should be "32,768".

Errata for Chapter 9

1. Page 277: In the first line of the third paragraph, "For Step 4" should be "For Step **2**". Additionally, in the first and second lines of the fifth paragraph, "measurements of three different bases on two particles" should be "measurements **on** three different bases **of** two particles". Finally, in the sixth line of the sixth paragraph, "(i.e., not independent)" should be "(i.e., **are** independent)".

2. Page 280: In Equation (9.45), the second line (the first line of $|\varphi_4\rangle$) must have an additional parenthesis at the end.

3. Page 281: In Equation (9.46), "$|\phi_4\rangle$" should be "$|\varphi_4\rangle$". Additionally, in the second line above Equation (9.47), "$|01\rangle$" should be "$|10\rangle$".

4. Page 348: In the answer to Exercise 9.1.1, "$DEC(-K_D)$" should be "$DEC(-, K_D)$".

5. Page 348: The answer to Exercise 9.2.1 has three errors:
   in the third line, "$\frac{1}{\sqrt{2}}|\uparrow\rangle$" should be "$-\frac{1}{\sqrt{2}}|\uparrow\rangle$";
   in the seventh line, "$-\frac{1}{\sqrt{2}}|\nearrow\rangle$" should be "$-1|\nearrow\rangle$";
   in the eighth line, "$-\frac{1}{\sqrt{2}}|\nwarrow\rangle$" should be "$-1|\nwarrow\rangle$".

Errata for Chapter 10

1. Page 286: Equation (10.5). The P's should be lowercase. N.S.Y. 8/30/2008.

2. Page 286: In Equation (10.4), the first "$p(B) = \frac{1}{4}$" should be "$p(A) = \frac{1}{4}$".

3. Page 290: (Typo) In Equation (10.21), "$\langle v|w_2|\rangle$" should be "$\langle v|w_2\rangle$".

4. Page 291: In Equation (10.26), "v" should be "w" (four times).

5. Page 292: In the first and second lines above Equation (10.38), "as in Example 10.2.1" should be "as in Example 10.2.2".

6. Pages 292-293: In the second line of Exercise 10.2.4, "$\mathbb{C}^n$" should be "$\mathbb{C}^m$, as in the first line above Equation (10.11). For the same reason, in Equation (10.41) and in the first line below Equation (10.42), "λ_n" should be "λ_m", in Equation (10.42) "$\sum_1^n$" should be "$\sum_1^m$", and in Equation (10.43) "e_n" should be "e_m".

7. Page 293: In the second line below Equation (10.43), "Equation (10.47)" should be "Equation (10.41)".

8. Page 294: In the first line of Exercise 10.2.5, "Examples 10.2.1, 10.2.2, and 10.2.3" should be "Examples 10.2.2, 10.2.3, and 10.2.4". Only in Example 10.2.4 were calculated eigenvectors and eigenvalues.

9. Page 298: In the second line of Exercise 10.3.2, "$\frac{1-n_0}{n}$" should be "$1 - \frac{n_0}{n}$" or "$\frac{n-n_0}{n}$".

10. Page 299: In the second and fourth lines below Equation (10.61), "$P_k(QC(|m\rangle)$" should be "$P_k(QC(|m\rangle))$" (twice). Additionally, in the next line, "$Pi(QC(|m\rangle)00...0\rangle$" should be "$|P_k(QC(|m\rangle))00...0\rangle$". Finally, Equation (10.62) should be rewritten as

$$|\langle QC^{-1}\left(|P_k(QC(|m\rangle))00...0\rangle\right)|m\rangle|^2,$$

11. Page 301: In Equation (10.66), "0.255" should be "0.526", "0.229" should be "0.230", and "0.850" should be "0.851".

12. Page 301: In the third line below Equation (10.66), "of Equation (10.71)" should be "of Equation (10.66)". Additionally, two lines below, the message "$|w_1w_1w_1w_1w_1w_1w_1w_1w_2w_2\rangle$" should be the message "$|w_1w_1w_1w_1w_1w_1w_1w_2w_2\rangle$" (only eight w_1) and "$|e_1e_1e_1e_1e_1e_1e_1e_1e_1e_1e_1e_1\rangle$" should be "$|e_1e_1e_1e_1e_1e_1e_1e_1e_1e_1\rangle$" (only ten e_1). Finally, Equation (10.67) should be rewritten as

$$|c_1| = (|\langle e_1|w_1\rangle|)^8(|\langle e_1|w_2\rangle|)^2 = 3.08 * 10^{-4}.$$

(Note the two extra parenthesis.)

13. Page 301: In the fourth and fifth lines below Exercise 10.3.4, "Equations (10.54) and (10.55)" should be "Equations (10.49) and (10.50)".

14. Page 303: In the first line of Exercise 10.4.2, "Block" should be "Bloch". Additionally, in the footnote 10, change "quantum code" to "quantum error-correction code".

15. Page 348: In the answer to Exercise 10.1.3, "$H(S)$" should be "H_S", according to the notation used in Section 10.1 [Equations (10.6)-(10.9)].

16. Page 349: The answer to Exercise 10.4.1 is not correct. In the fourth and sixth lines, "$(0.25)^2$" should be "$(0.25)^2(0.75)$" (twice). And in the sixth line, "0.20312" should be "0.15625".

Errata for Chapter 11

1. Page 305: In the quote at the top of the page, "Saint Exupery" should be "Saint-Exupéry".

2. Page 306: In the third line of Section 11.1, "sequence of unitary transformation" should be "sequence of unitary transformations".

3. Page 307: In the footnote 3, the denominator "$\sqrt{2}$" should be "2", according to definition (10.14) of page 288. (Note that the trace of any density matrix must be 1.)

4. Page 308: In the Definition 11.1.1, "interaction" instead of "entanglement". Additionally, in the eighth line below that Definition, "(see Section 4.3)" should be "(see Section 4.4)".

5. Page 309: In the second line below Equation (11.3), "tensor product" instead of "tensor".

6. Page 311: In the thirteenth line of Section 11.2, "sumnmarize" should be "summarize". Additionally, in the third line of the last paragraph, "ion, or **cations**" should be "ions, or **cations**". Finally, in the footnote 8, "C. Monroe and D. Wineland" should be "Monroe et al.", and "a year earlier" should be "some months earlier". [The first article is J. I. Cirac and P. Zoller, *Phys. Rev. Lett.* **75**(20), 4091-4 (May 1995), and the second is C. Monroe, D. M. Meekhof, B. E. King, W. M. Itano and D. J. Wineland, *Phys. Rev. Lett.* **75**(25), 4714-7 (December 1995).]

7. Page 313: In the eighth line of Section 11.3, "coherent beam of light" should be "polarized beam of light". [A coherent beam is something more restrictive.] Additionally, in the next line, "specific plane" should be "specific direction".

8. Page 314: In the third line below Figure 11.6, "Franson (2004)" should be "Franson (2004))".

9. Page 349: The answer to Exercise 11.1.2 has some errors. First, in the second line, "of the column vector" should be "the column vector". Second, Equation (B.115) should be

$$A = \frac{1}{\sqrt{2}}\begin{bmatrix}1, & e^{-i\theta}\end{bmatrix}\frac{\hbar}{2}\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}\frac{1}{\sqrt{2}}\begin{bmatrix}1, & e^{i\theta}\end{bmatrix}^T.$$

(Note that "h" was replaced by "$\hbar$".) Third, Equation (B.116) should be

$$A = \frac{\hbar}{4}\left(e^{-i\theta} + e^{i\theta}\right),$$

and Equation (B.117) should be

$$A = \frac{\hbar}{2}\cos(\theta).$$

Errata for Appendices A, C and E

1. Page 323: In the sixth line above Section A.6, "Claude Crépeau Brassard" should be "Claude Crépeau, Brassard".

2. Page 351: In the last paragraph, "$c = 5 + i$" should be "$c = 5 + 5i$" (twice), and "$c = 5.000 + 1.000i$" should be "$c = 5.000 + 5.000i$". Justification: Only in this way the values of s, p and r on Page 352 are correct.

3. Page 352: In the second line, "$c = 5 + j$" should be "$c = 5 + 5j$", and in the third line, "$c = 5.000 + 1.000i$" should be "$c = 5.000 + 5.000i$". Additionally, in the thirteenth line, "$c1 = 5.000 - 1.000i$" should be "$c1 = 5.000 - 5.000i$". Finally, in the 22th line, "angle(c)" should be "a=angle(c)", "ans=0.78540" should be "a=0.78540", and "c1=r∗exp(i∗a)" should be "c=r∗exp(i∗a)". [See the justification of item 2.]

4. Page 353: In the tenth line, "$0 + 3i$" should be "$0 - 3i$". Additionally, in the eleventh line, "complex conjugate" should be "adjoint".

5. Page 371: In the third line of Section E.11.2, "end of Section 11.3" should be "end of Section 11.4".

6. Page 372: In the last line QKD is "quantum key distribution" which was never defined.