Errata for Quantum Computing – A short course from theory to experiment

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This is a list of errors for which we apologize. We hope this list will be of some use to our readers. We will update the list as we learn about any newly detected errors. We encourage all readers to notify us about further errors which are somewhere out there, no doubt.

In the second edition of our book some errors from the first edition were eliminated while we keep detecting more errors, old and new. Below, we first list the errors from the second edition.

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Errors from the second edition

- p. 142: The second sentence of the third paragraph should read: "For single qubits, whose ideal form (5.10) may be parametrized with four angles (defining an axis of rotation, an angle of rotation, and a phase), deviations may correspond to errors in these angles."
- p. 148: The first two sentences should read: "Detection of single photons is possible using avalanche photo diodes (APDs) or photomultiplier tubes (PMTs). APDs offer higher quantum efficiencies (up to 70% in the visible, using commercial devices, and more with custom-built systems), while PMTs provide shorter dead times."
- p. 189: The first sentence below the figure should read: "For suitable transitions, up to 10^8 photons per second can be scattered."

Errors from the first edition

- p. 23: In Equations (2.4) and (2.5) the left-hand sides are supposed to read $|\Psi(0)\rangle$ and $|\Psi(t)\rangle$, respectively, and the fractions on the right-hand sides are $\frac{1}{\sqrt{2}}$ in both equations.
- p. 31: Spaces are missing at the beginning of Subsection 3.2.5. The text should read "... or CNOT, also..." and "...the target bit y...".
- p. 33: A space is also missing at the beginning of Subsection 3.3.1 The text should read "The Turing machine acts...".
- p. 34: Third and second to last lines: delete ",such as text processing etc.)".
- p. 56: The unnumbered equation before (4.83) should read

$$(x, y) \longrightarrow (x, x \text{ XOR } y).$$

- p. 57: Equation (4.90) should read

$$\left(\langle s| \otimes \langle\psi|\mathbf{U}^\dagger\right)\left(\mathbf{U}|\phi\rangle \otimes |s\rangle\right) = \left(\langle\psi| \otimes \langle\psi|\right)\left(|\phi\rangle \otimes |\phi\rangle\right) = \left(\langle\psi|\phi\rangle\right)^2$$

- p. 60/61: In Equation (4.93) and the subsequent paragraph, $\mathbf{O}_A$ is to be replaced by $\mathbf{O}_S$. In the third line below (4.93) $\mathbf{A}$ is to be replaced by $\mathbf{O}_S$.

- p. 65: In Equation (5.9) the trigonometric functions crept into the exponents. The correct equation is

$$\mathbf{R}_{\hat{z}}(\alpha)|\theta,\varphi\rangle = \begin{pmatrix} e^{i\alpha} & 0 \\ 0 & e^{-i\alpha} \end{pmatrix} \begin{pmatrix} e^{-i\frac{\phi}{2}} \cos\frac{\theta}{2} \\ e^{i\frac{\phi}{2}} \sin\frac{\theta}{2} \end{pmatrix}$$

$$= \begin{pmatrix} e^{-i\frac{\phi-2\alpha}{2}} \cos\frac{\theta}{2} \\ e^{i\frac{\phi-2\alpha}{2}} \sin\frac{\theta}{2} \end{pmatrix} = |\theta, \phi - 2\alpha\rangle.$$

- p. 69: The set of universal gates should contain $\mathbf{H}^{\frac{1}{2}}$ rather than $\mathbf{H}$ because $\mathbf{H}^{\frac{1}{2}}$ is explicitly needed in Subsection 5.3.4. Note that while $\mathbf{H}$ can be obtained from $\mathbf{H}^{\frac{1}{2}}$ by a simple multiplication, the reverse is not true, as evident from Equation (5.43). The idea of a universal set of gates, however, is to construct arbitrary operations by *multiplication*.

  In item 2. of the list at the end of subsection 5.3.1, "i)" should be replaced by "1.".

- p. 90 / 91: In the last line of p. 90 and in the first line of p. 90 "qubits" should read "bits".

- p. 107 / 108: In the list above Equation (8.3) the entries for f_3 and f_4 must be exchanged to be consistent with Equation (8.3). The corresponding matrices in Equation (8.7) must also be exchanged.

- p. 114: In step 5) of the factor-finding algorithm the condition should, strictly speaking, read "$x^{r/2} \bmod N \neq N - 1$".

- p. 123 / 124: Several state vectors $|0\rangle$ should read $|\vec{0}\rangle$. Note that the vector $|x\rangle$ for $x = 0$ is identical to $|\vec{0}\rangle$ since all of the n bits of x are zero. Specifically the last line of text on p. 123 should read "...basis states except $|\vec{0}\rangle$:". On p. 124, every "0" in Equations (8.78) and (8.79) and in the text in between should read "$\vec{0}$".

- p. 127: In Equation (8.92) "$|0\rangle$" should read "$|\vec{0}\rangle$".

- p. 138: The second sentence of the third paragraph should read: "For single qubits, whose ideal form (5.10) may be parametrized with four angles (defining an axis of rotation, an angle of rotation, and a phase), deviations may correspond to errors in these angles."

- p. 159: The text after Equation (10.46) should read: "The last version is the shortest: a $\left(\frac{\pi}{2}\right)_y$ pulse is followed by a π_z rotation, which can be implemented, e.g., by a phase shift."

- p. 170: The text below Figure 10.21 should read: "After the inverse QFT, qubit 3 is the most significant qubit. The resulting state is therefore a mixture of $|100\rangle$ = $|4\rangle$ and $|000\rangle$ = $|0\rangle$. This indicates that the period of the probability (8.44) is $p = 4$. Since $n = 3$

qubits were used the desired number r is given by (see Section 8.3.3) $r = 2^n/p = 2$. A classical calculation yields the greatest common divisor of $11^{2/2} \pm 1$ and 15 as 3 and 5, and thus directly the prime factors of N."

- p. 184: The first sentence should read: "For suitable transitions, up to 10^8 photons per second can be scattered."
- p. 202: Delete the two square-root symbols in Equation (13.5).
- p. 204: The intermediate steps in Equations (13.11) and (13.12) are potentially confusing; furthermore, (13.12) contained a sign error (of no significant consequences). The two equations should read

  $$\mathbf{H}(|1\rangle + |0\rangle) = \sqrt{2}|0\rangle$$

  and

  $$\pm\mathbf{H}(|0\rangle - |1\rangle) = \pm\sqrt{2}|1\rangle$$

  .
- Bibliography: Even classical computers behave in unexpected ways sometimes. Somewhere between the various computer systems used for processing our manuscript some of the references were garbled. Below is a list of references together with the journal titles which are missing in the printed book. We apologize to the authors of those papers.

  BB03 *Phys. Rev. Lett.*
  BBC$^+$93 *Phys. Rev. Lett.*
  BBM92 *Phys. Rev. Lett.*
  BDSW96 *Phys. Rev. A*
  BK02 *Phys. Rev. A*
  BRB$^+$03 *Appl. Phys. Lett.*
  BvLvdHS02 *Phys. Rev. Lett.*
  BW92 *Phys. Rev. Lett.*
  CDF$^+$03 *Phys. Rev. A*
  CGK98 *Phys. Rev. Lett.*
  CHSH69 *Phys. Rev. Lett.*
  CZKM97 *Phys. Rev. Lett.*
  DRKB02 *Phys. Rev. A*
  EJ96 *Rev. Mod. Phys.*
  GKP01 *Phys. Rev. A*
  GMD02 *Rev. Mod. Phys.*
  Gro97 *Phys. Rev. Lett.*
  GRTZ02 *Rev. Mod. Phys.*
  KLV00 *Phys. Rev. Lett.*
  KWM$^+$98 *Phys. Rev. Lett.*
  LCW98 *Phys. Rev. Lett.*
  LMPZ96 *Phys. Rev. Lett.*

MFGM01 *Phys. Rev. A*
MMJ03 *Phys. Rev. Lett.*
MMR00 *Phys. Rev. B*
MMS03 *Phys. Rev. Lett.*
MSM+02 *Phys. Rev. A*
MW01 *Phys. Rev. Lett.*
NHTD78 *Phys. Rev. Lett.*
RB01 *Phys. Rev. Lett.*
RGM+03 *Phys. Rev. A*
RZR+99 *Phys. Rev. Lett.*
Sho95 *Phys. Rev. A*
SOG+02 *Phys. Rev. A*
SS03 *Phys. Rev. B*
Twa03 *Phys. Rev. A*
WDW78 *Phys. Rev. Lett.*
Woo98 *Phys. Rev. Lett.*
ZR97 *Phys. Rev. Lett.*