Changes, clarifications, and errata

This document describes changes between versions of the book *Dancing with Qubits* by Robert S. Sutor and published by Packt Publishing. It does not include minor changes in formatting or punctuation.

The changes in one printing were incorporated into all later printings. The page numbers refer to the paperback version of the book.

Changes after the First Edition, third printing, June 2021, Production reference 1290421

Section	New Page	Old Text	New Text
3.5.3	82	$\begin{array}{ccc} s & b & r \\ \hline & . & .2 \\ .4 & .0 & .4 \\ .8 & .00 & .8 \\ 1.6 & .0001 & .6 \\ 1.2 & .00011 & .2 \\ .4 & .000110 & .4 \\ \vdots & \vdots & \vdots \end{array}$	$\begin{array}{ccc} s & b & r \\ \hline & . & .2 \\ .4 & .0 & .4 \\ .8 & .00 & .8 \\ 1.6 & .001 & .6 \\ 1.2 & .0011 & .2 \\ .4 & .00110 & .4 \\ \vdots & \vdots & \vdots \end{array}$
3.5.3	82	$.2_{10} = .\overline{00011}_2$	$.2_{10} = .\overline{0011}_2$
3.9.2	98	$\mathrm{Im}(z) = -\mathrm{Im}(\overline{z}) = -b$	$\mathrm{Im}(\overline{z}) = -\mathrm{Im}(z) = -b$
4.3.2	127	$\arcsin(x)$ is a function with domain $-1 \leq x \leq 1$ and range $\boxed{\frac{\pi}{2}} \leq \arcsin(x) \leq \frac{\pi}{2}$.	$\arcsin(x)$ is a function with domain $-1 \leq x \leq 1$ and range $\boxed{-\frac{\pi}{2}} \leq \arcsin(x) \leq \frac{\pi}{2}$.
4.3.2	128	$\arctan(x)$ is a function with domain all of $\mathbb{R}$ and range $\boxed{\frac{\pi}{2}} < \arctan(x) < \frac{\pi}{2}$.	$\arctan(x)$ is a function with domain all of $\mathbb{R}$ and range $\boxed{-\frac{\pi}{2}} < \arctan(x) < \frac{\pi}{2}$.
7.2	230	$\|v\rangle\langle w\| = \begin{bmatrix} v_1\overline{w_1} & v_1\overline{w_2} & \cdots & v_1\overline{w_m} \\ v_2\overline{w_1} & v_2\overline{w_2} & \cdots & v_2\overline{w_m} \\ \vdots & \vdots & \ddots & \vdots \\ v_2\overline{w_1} & v_2\overline{w_2} & \cdots & v_2\overline{w_m} \end{bmatrix}.$	$\|v\rangle\langle w\| = \begin{bmatrix} v_1\overline{w_1} & v_1\overline{w_2} & \cdots & v_1\overline{w_m} \\ v_2\overline{w_1} & v_2\overline{w_2} & \cdots & v_2\overline{w_m} \\ \vdots & \vdots & \ddots & \vdots \\ v_n\overline{w_1} & v_n\overline{w_2} & \cdots & v_n\overline{w_m} \end{bmatrix}.$
7.3.3	239	For $\|\psi\rangle$ expressed generally by $\boxed{r_1 e^{\varphi_1 i}\|1\rangle\|0\rangle} + r_2 e^{\varphi_2 i}\|1\rangle$	For $\|\psi\rangle$ expressed generally by $\boxed{r_1 e^{\varphi_1 i}\|0\rangle} + r_2 e^{\varphi_2 i}\|1\rangle$

Section	New Page	Old Text	New Text
7.4	246	The inverse function $f^{-1}(a)$ for an a in $\mathbb{R}$ is defined by $f^{-1}(a) = \begin{cases} (0,-1) & \text{when } a = 0 \\ \left(\frac{4a}{4+a^2} + \sqrt{1-\left(\frac{4a}{4+a^2}\right)^2}\right) & \text{when } \lvert a\rvert \geq 1 \\ \left(\frac{4a}{4+a^2} - \sqrt{1-\left(\frac{4a}{4+a^2}\right)^2}\right) & \text{otherwise} \end{cases}$	The inverse function $f^{-1}(a)$ for an a in $\mathbb{R}$ is defined by $f^{-1}(a) = (x, y)$ where $(x, y) = (0, -1)$ when $a = 0$, and $x = \begin{cases} \frac{4a}{4+a^2} + \sqrt{1-\left(\frac{4a}{4+a^2}\right)^2} & \text{when } \lvert a\rvert \geq 1 \\ \frac{4a}{4+a^2} - \sqrt{1-\left(\frac{4a}{4+a^2}\right)^2} & \text{otherwise} \end{cases}$ with $y = -\frac{2}{a}x + 1$.
7.5	249	$r_1 e^{\varphi_1 i}\lvert 0\rangle + r_2 e^{\varphi_2 i}\lvert 1\rangle = \left(e^{\varphi_1 i}\right)\left(r_1\lvert 0\rangle + r_2 e^{i\left(\varphi_2-\varphi_2\right)}\lvert 1\rangle\right)$	$r_1 e^{\varphi_1 i}\lvert 0\rangle + r_2 e^{\varphi_2 i}\lvert 1\rangle = \left(e^{\varphi_1 i}\right)\left(r_1\lvert 0\rangle + r_2 e^{i\left(\varphi_2-\varphi_1\right)}\lvert 1\rangle\right)$
7.5	249	if the difference is $\boxed{\text{negative.ß}}$	if the difference is $\boxed{\text{negative}}$.
8.2.2	282	$\lvert 0\rangle\langle 0\rvert = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} \quad \text{and} \quad \lvert 1\rangle\langle 0\rvert = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}.$	$\lvert 0\rangle\langle 0\rvert = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix} \quad \text{and} \quad \lvert 1\rangle\langle 0\rvert = \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}.$

Changes after the First Edition, second printing, February 2020, Production reference 2230120

These changes should be applied to the text in this edition.

Section	New Page	Old Text	New Text
2.1	27	Thus a terabyte is $10^{12} = \boxed{1{,}000{,}000{,}000}$ bytes.	Thus a terabyte is $10^{12} = \boxed{1{,}000{,}000{,}000{,}000}$ bytes.
2.1	28	If I change bit 6 in ‘a’ to a 0, I get $\boxed{\text{the character ‘1’.}}$	If I change bit 6 in ‘a’ to a 0, I get $\boxed{\text{the character ‘!’.}}$
2.5	40	produces a 2-bit answer $\boxed{CD}$.	produces a 2-bit answer $\boxed{CS}$.
3.4.2	73	the square of an odd integer looks like $\boxed{4k^2 + 2k + 1}$	the square of an odd integer looks like $\boxed{4k^2 + 4k + 1}$
7.7	266	$\boxed{c_{\sigma_x}\ c_{\sigma_y}, \text{ and } c_{\sigma_z}}$ are Pauli matrices	$\boxed{\sigma_x\ \sigma_y, \text{ and } \sigma_z}$ are Pauli matrices

Section	New Page	Old Text	New Text
8.2.1	280	the tensor products of two 1-qubit kets: $\lvert\psi\rangle_1 \otimes \lvert\psi\rangle_2 =$ $(a_1\lvert 0\rangle_1 + b_1\lvert 1\rangle_1) \otimes$ $\boxed{(a_1\lvert 0\rangle_1 + b_2\lvert 1\rangle_1)}$	the tensor products of two 1-qubit kets: $\lvert\psi\rangle_1 \otimes \lvert\psi\rangle_2 =$ $(a_1\lvert 0\rangle_1 + b_1\lvert 1\rangle_1) \otimes$ $\boxed{(a_2\lvert 0\rangle_2 + b_2\lvert 1\rangle_2)}$
8.2.2	282	and we have $\lvert a_0\rvert^2 + \lvert a_1\rvert^2 + \lvert a_2\rvert^2 + \cdots + \boxed{\lvert 2^n - 1\rvert^2} = 1.$	and we have $\lvert a_0\rvert^2 + \lvert a_1\rvert^2 + \lvert a_2\rvert^2 + \cdots + \boxed{\lvert a_{2^n-1}\rvert^2} = 1.$
8.3.1	287	*summations like* $\boxed{\sum_{j=0}^{n-1}}$ *at the end of the section* $\boxed{\mathbf{H}^{\otimes 4}\lvert 0\rangle = \frac{1}{\sqrt{2^4}}\sum_{j=0}^{3}\lvert j\rangle}$	*should be changed to* $\boxed{\sum_{j=0}^{2^n-1}}$ $\boxed{\mathbf{H}^{\otimes 4}\lvert 0\rangle = \frac{1}{\sqrt{2^4}}\sum_{j=0}^{2^4-1}\lvert j\rangle}$
9.6.2	328	we are talking about the balanced superposition ket $\boxed{\lvert\varphi\rangle = \mathbf{H}^{\otimes 2}\lvert 000\rangle\mathbf{H}^{\otimes 2}.}$	we are talking about the balanced superposition ket $\boxed{\lvert\varphi\rangle = \mathbf{H}^{\otimes 3}\lvert 000\rangle.}$
9.8.2	343	Note how the how the signs reverse.	Note how the signs reverse.
10.2.3	371	Keep going until N is not prime.	Keep going until N is not odd.
10.2.3	376	Let's try $N = 143$. $s = 11$ and since $\boxed{s^2 \neq 144}$, set $u = s + 1 = 12$.	Let's try $N = 143$. $s = 11$ and since $\boxed{s^2 \neq 143}$, set $u = s + 1 = 12$.
10.2.4	378	The the integer square root of N is 4.	Then the integer square root of N is 4.
11.4.2	418	but we are looking the longitudinal decoherence.	but we are looking at the longitudinal decoherence.
12.1	446	What role or roles do you play in the quantum computing ecosystem are you?	What role or roles do you play in the quantum computing ecosystem?

First Edition, second printing, February 2020, Production reference 2230120

The changes are relative to the version above. This included a refresh of the print and PDF eBook. The Amazon Kindle version was first introduced here and includes these changes.

Section	New Page	Old Text	New Text
1.1	4	problems that $\boxed{\text{cuurently}}$ appear	problems that $\boxed{\text{currently}}$ appear
3.3	64	$12 = 3 \times 4$	$12 = 3 \times 4 \boxed{= 2^2 \times 3}$
3.4	73	this shows n^2 and n are *even*	this shows $\boxed{\text{that}}$ n^2 and n are *even*
3.5.1	75	to $\boxed{10^{-1}} = \frac{1}{100}$ = one hundreth	to $\boxed{10^{-2}} = \frac{1}{100}$ = one hundreth
3.5.4	85	and, second, $\boxed{\text{the}}$ have	and, second, $\boxed{\text{they}}$ have
3.6.2	92	$\left(a + b\sqrt{2}\right) \times \left(c + d\sqrt{2}\right) =$ $(ac + 2bd) + \boxed{\left(ad + bc\sqrt{2}\right)}$	$\left(a + b\sqrt{2}\right) \times \left(c + d\sqrt{2}\right) =$ $(ac + 2bd) + \boxed{(ad + bc)\sqrt{2}}$
3.6.4	93		**Delete the third bullet starting** "There exists a unique element *id*".
3.8	96	$(a, b) + (c, d) = \boxed{(a + c) + (b + d)}$	$(a, b) + (c, d) = \boxed{(a + c, b + d)}$
3.9	101	Just as $\mathbb{Z}$ fixed the subtraction $\boxed{\text{close}}$ problem for $\mathbb{N}$	Just as $\mathbb{Z}$ fixed the subtraction $\boxed{\text{closure}}$ problem for $\mathbb{N}$
4.1	111	If f and g are functions such that $g(f(x)) = x$ $f(g(y)) = y$	If f and g are functions such that $g(f(x)) = x$ $\boxed{\text{and}}$ $f(g(y)) = y$
4.2.1	112	upper right side of the graph and $(\boxed{\frac{5}{2}}, -1)$ in the lower left	upper right side of the graph and $(\boxed{-\frac{5}{2}}, -1)$ in the lower left
		The third and fourth quadrants have $x < 0$ and $y < 0$, and $x > 0$ and $\boxed{y > 0}$, respectively.	The third and fourth quadrants have $x < 0$ and $y < 0$, and $x > 0$ and $\boxed{y < 0}$, respectively.
5.1	139	If $u = (u_1, u_2)$ and $\boxed{v = (v1, v_2)}$,	If $u = (u_1, u_2)$ and $\boxed{v = (v_1, v_2)}$,
5.3.2	150	The linear transformations $(x, y) \mapsto (-x, y)$ $(x, y) \mapsto (x, -y)$	The linear transformations $(x, y) \mapsto (-x, y)$ $\boxed{\text{and}}$ $(x, y) \mapsto (x, -y)$
5.7.2	178	$\langle \mathbf{v}, \mathbf{v} \rangle = 0$ if and only $\mathbf{v}$ is zero.	$\langle \mathbf{v}, \mathbf{v} \rangle = 0$ if and only $\boxed{\text{if}}$ $\mathbf{v}$ is zero.
5.11.2	201	The function $f : \mathbf{R} \to \mathbf{S}$ is a $\boxed{\textit{homomorphism ring}}$ if	The function $f : \mathbf{R} \to \mathbf{S}$ is a $\boxed{\textit{ring homomorphism}}$ if
5.11.3	202	$f(\mathbf{v} + \mathbf{w}) = f(\mathbf{v}) + \boxed{(\mathbf{w})}$	$f(\mathbf{v} + \mathbf{w}) = f(\mathbf{v}) + \boxed{f(\mathbf{w})}$

Section	New Page	Old Text	New Text
6.5	212	with associated probabilities $\boxed{p_1, p_2, p_3,}$ and $\boxed{p_4}$	with associated probabilities $\boxed{p_0, p_1, p_2,}$ and $\boxed{p_3}$
6.7	217	$\boxed{\Pr X} > a$	$\boxed{\mathrm{P}\,(X)} > a$
6.7	219	$\boxed{\Pr}$(**we get 7 or fewer heads**)	$\boxed{\mathrm{P}}$(**we get 7 or fewer heads**)
7.2	230	When $n = m$, the bra-ket $\langle v \vert w \rangle = \langle v \vert\, \vert w \rangle = (\langle v \vert)\,(\vert w \rangle)$ $\boxed{\text{of } \mathbf{v} \text{ and } \mathbf{w}}$ is the usual *inner product*.	When $n = m$, the bra-ket $\langle v \vert w \rangle = \langle v \vert\, \vert w \rangle = (\langle v \vert)\,(\vert w \rangle)$ is the usual *inner product*.
7.6.6	260	These gates change the phase of a qubit state by $\boxed{\vartheta}$.	These gates change the phase of a qubit state by $\boxed{\varphi}$.
7.8	267		*removed "eprint" from reference to make Kindle version work correctly*
8.2.1	276	be the standard orthonormal basis kets for each of their $\mathbb{C}^2$ state spaces.	be the standard orthonormal basis kets for each of their $\mathbb{C}^2$ state spaces. $\boxed{\text{Let}}$
		$\vert\psi\rangle_1 = a_1\vert 0\rangle_1 + b_1\vert 1\rangle_1$ with $\vert a_1\vert^2 + \vert b_1\vert^2 = 1$	$\vert\psi\rangle_1 = a_1\vert 0\rangle_1 + b_1\vert 1\rangle_1$ with $\vert a_1\vert^2 + \vert b_1\vert^2 = 1$ $\boxed{\text{and}}$
	278	Is it still true that the sum of the squares of the absolute values of the coefficients $\boxed{\text{still}}$ equals 1?	Is it still true that the sum of the squares of the absolute values of the coefficients equals 1?
8.3.1	286	This is a situation where the decimal $\boxed{\text{expressions for the ket bases}}$ is concise.	This is a situation where the decimal $\boxed{\text{expression for a basis ket}}$ is concise.
8.3.3	290	It is a permutation matrix that swaps the third and fourth coefficients of $\boxed{\vert\psi\rangle_1 \otimes 2\vert\psi\rangle_2}$.	It is a permutation matrix that swaps the third and fourth coefficients of $\boxed{\vert\psi\rangle_1 \otimes \vert\psi\rangle_2}$.
9.7.2	333	Here is an explicit search as you might do it in the IBM Q Experience.	Here is an explicit search as you might do it in the IBM Q Experience, though the qubits are shown in reverse order there.
9.9	354	Simon's algorithm was the inspiration $\boxed{\text{to}}$ Peter Shor	Simon's algorithm was the inspiration $\boxed{\text{for}}$ Peter Shor
10.1	359	"ω" is the lowercase $\boxed{\text{greek}}$ letter "omega."	"ω" is the lowercase $\boxed{\text{Greek}}$ letter "omega."
10.5.1	390	The $\vert y\rangle$ are the computational basis vectors in a $\boxed{2^{\ell_{\text{bits}}}}$ vector space over $\mathbb{C}$.	The $\vert y\rangle$ are the computational basis vectors in a $\boxed{2^{\ell_{\text{bits}}}\text{-dimensional}}$ vector space over $\mathbb{C}$.
11.4.1	417	$p_t = Pr\vert 1\rangle$	$p_t = \mathrm{P}\,(\vert 1\rangle)$
11.4.2	420	$p_t = Pr\vert 1\rangle$	$p_t = \mathrm{P}\,(\vert 1\rangle)$

Section	New Page	Old Text	New Text
11.10	442	Superconducting transmon qubits are used by $\boxed{\text{IBM}}$ and others	Superconducting transmon qubits are used by $\boxed{\text{IBM, Google,}}$ and others *removed "eprint" from references to make Kindle version work correctly*
D	471	James Yu's LaTeX Workshop extension made creating this book much easier.	James Yu's LaTeX Workshop extension made creating this book much easier. tex4ht and make4ht were used with custom Python and sed scripts to produce the eBook.

One index entry changed because of a small and localized pagination change in the text.

First Edition, first printing, November 2019, Production reference 1251119

This was the very first version made available in print and in PDF eBook. It did not have an Amazon Kindle or any other MOBI or EPUB3 format.