

## ERRORS IN HACKER'S DELIGHT

First, second, fourth, and fifth printings

P. 2: The latest C standard allows `//`-style comments. Therefore, replace the entire second paragraph with “Programs too long or complex for computer algebra are written in the C programming language, as defined by the ISO 1999 standard.”

—Derek M. Jones

P. 4 line 14: Append a semicolon in the “code” font, so that the line is

`do statement while (expression) ;`

P. 11 line 8: Add the phrase “or is 0,” so that it reads “This may be used to determine if an unsigned integer is a power of 2 or is 0; apply ....”

P. 15 line 4: Change the colon to “formulas.” and add “(The first two methods can fail on a machine that has modulo 32 shifts.)”

—Ray Roth

P. 18 lines 17-18: Replace the sentence “Assuming the machine has mod 64 shifts, the first four formulas hold for  $0 \leq n \leq 31$ , and the last holds for  $0 \leq n \leq 63$ .” to “These formulas hold for  $0 \leq n \leq 31$  and, if the machine has mod 64 shifts, the last holds for  $0 \leq n \leq 63$ .”

P. 24: In the second expression for “ $x = y$ ,” there should be a bar over the  $y$  (it should read “or carry  $((x + \bar{y}) + 1)$ ”).

—Simon Frankau

P. 27-28: Near the bottom of p. 27, the second expressions for checking for overflow of signed addition and subtraction need another pair of parentheses and can be simplified slightly. They should be:

$$z \ \& \ (((x \oplus z) + y + c) \equiv y) \quad z \ \& \ (((x \oplus z) - y - c) \oplus y)$$

On the fifth line up from the bottom of the page, “...is done with  $x$  and  $y$  having...” should be “...is done with  $x \oplus z$  and  $y$  having...”.

On the first line of p. 28, “The term  $x \equiv y$  ensures...” should now be “The *and* with  $z$  ensures...”.

—Eljay Love-Jensen

P. 40 paragraphs 4 and 5: One cycle count and three instructions counts are incorrect. The material, starting from the fourth text line of the fourth paragraph, should read:

1's in fields *A*, *C*, and *E*. This code requires 11 instructions and six cycles on a machine with unlimited instruction-level parallelism, allowing for four instructions to load the two masks.

A method that requires only eight instructions ....

P. 42: The equation near the top of the page should be number (4), and the references on lines 10 and 15 should be (4).

P. 48: In Figure 3–2, left column, “return” should be “return  $y_i$ ”.

—John P. Linderman

P. 52: In the second line of Case 3, “ $b > a$ ” should be “ $b \geq a$ ”.

—John P. Linderman

P. 68: To use a C operator rather than a function call, in the program near the top of the page, lines 8 and 9 (`x = modu(x, 63) ...` and `return x;`) should be replaced with the single line:

```
return x%63; // Add 6-bit sums.
```

P. 68 line 17: The two occurrences of  $b$  should be  $b - 1$ , so that the sentence is “... mod  $b - 1$  to the sum of the digits and, of course, is less than  $b - 1$ .”

—Svend Jacobsen

P. 68 line 24: “13 instructions” should be “15 instructions”.

P. 69 line 7: “This is 19 instructions” should be “This is 20 instructions”.

P. 75: The last line of the second paragraph should read “own inverse,  $y_i \oplus y_j$  is the parity of bits  $i - 1$  through  $j$  of  $x$ , for  $i \geq j$ .”

—Michael Pyne

P. 75: In the middle of the third paragraph, replace the sentence fragment “you can first use (3) on each word of the array, and then use essentially the same technique on the array, doing ...” with “you can first use (3) on the entire array, and then continue with shifts of 32 bits, 64 bits, and so on, doing ...”.

P. 75, second from last paragraph, add the sentence: “This is called the “parallel suffix” operation, because each bit is a function of itself and the bits that follow it.”

P. 82: This is a clarification, not a correction of an error. Append to the end of the third paragraph (after “... blocking the carry.”), “If  $k$  is a 64-bit quantity, this correction is also needed for the code of Figure 5–12 and for the first of the three variations given above.”

—Donald E. Knuth

P. 82: Macro NLZ near the bottom of the page should be altered to work correctly if evaluating the parameter has side effects. Change the first line of the NLZ macro to:

```
#define NLZ(kp) \
```

and the third line (`unsigned _kk = ...`) to:

```
    unsigned _k = (kp), _kk = _k & ~(_k >> 1); \
```

In the line of text just after this macro, change “k” to “kp”.

—Simon Frankau

P. 87: Change ‘It has been named the “ruler function” by Eric Jensen, because’ to ‘It has been called the “ruler function” because’. (Apparently Jensen was not the first to use the term “ruler function.”)

—Donald E. Knuth

P. 94: The “>>” symbol in the middle of the page should be “>>” (two greater-than signs in Courier New font).

The changes below, to pp 117–122, change “parallel prefix” to “parallel suffix,” essentially.

—Donald E. Knuth

P. 117 paragraph 3: Change “parallel prefix” to “parallel suffix” in two places, and change “PP-XOR” to “PS-XOR”.

P. 118 paragraph 2: Change “PP-XOR” to “PS-XOR” in two places.

P. 119 paragraph 1: Change “PP-XOR” to “PS-XOR. In Figure 7–6, change “// Parallel prefix.” to “// Parallel suffix.” And in the title of this figure, change “prefix” to “suffix”.

P. 120: In Figure 7–7, change the five occurrences of “After PP” to “After PS”. Also, in the title, change “prefix” to “suffix”.

P. 121, at the very end of paragraph 2: Change “Figure 7–7” to “Figure 7–6”.

P. 122 paragraph 3: Change “prefix” to “suffix” in two places.

P. 139, there are two places where “≠” should be “>”. In Theorem D3 and its corollary, change “integer ≠ 0” to “integer > 0”.

—Svend Jacobsen

P. 141 line 25: The comment should be `// 0 <= s <= 15`.

P. 144 line 5: Change “increases” to “decreases”.

—Nobuhisa Fujinami

P. 144 lines 23–24: Interchange two expressions, so that it reads “...loop is executed  $m - n + 1$  times, and the multiply/subtract loop  $n$  times, ...”.

—Nobuhisa Fujinami

P. 149 line 8: In the mathematical expression, “62” should be “64”.

—Nobuhisa Fujinami

P. 151 line 26: “u32” should be “un32”.

P. 156 line 2 of Section 10–2: The equation “ $r = q * 2^k - n$ ” should be “ $r = n - q * 2^k$ ”.

—Nobuhisa Fujinami

P. 156 line 5 of Section 10–2: “sub r, r, n” should be “sub r, n, r”.

—Nobuhisa Fujinami

P. 157 line 4: “seven” should be “six”.

—Nobuhisa Fujinami

P. 166, 5th displayed expression: The factor “ $n_{c+1}$ ” near the left should be “ $n_c + 1$ ” (retain the parentheses).

—Nobuhisa Fujinami

P. 167, line following inequality (13): Insert “+1”, so that it reads “For  $-n_c - d + 1 \leq n \leq -n_c - 1$ ,”.

—Nobuhisa Fujinami

P. 171 line 15: In the formula for  $n_c$ , one of the plus signs should be a minus sign. The first alternative should be “ $2^{W-1} - \text{rem}(2^{W-1}, d) - 1$ , if  $d > 0$ ,”. (The second alternative is ok.)

—Svend Jacobsen

P. 172 line 6: The equation “ $p = 2^{W-1}$ ” should be “ $p = W - 1$ ”.

—Nobuhisa Fujinami

P. 172, displayed inequality just below the middle of the page: Change “ $|d|$ ” to “ $|n_c|$ ”, so that it becomes

$$\frac{2^p}{|n_c|} > \delta.$$

—Nobuhisa Fujinami

P. 174 Figure 10–1, lines 20 and 25: Insert a right parenthesis just before the final period on these lines, so that they read

... = rem(2\*\*p, |nc|).

... = rem(2\*\*p, |d|).

—Nobuhisa Fujinami

P. 180, displayed formula near the top: Of the four terms separated by equal signs, the rightmost two should be surrounded by “ceiling” brackets, not “floor” brackets. But rather than make that correction, replace the entire displayed formula with the following simpler formula:

$$0 \leq q = \left\lceil \frac{Mn}{2^{32}} \right\rceil \leq n,$$

—Bob Roediger

P. 182, line preceding inequality (28): “rem( $2^p - 1, d$ )” should be “rem( $2^p - 1, d$ )”.

—Nobuhisa Fujinami

P. 184, 3rd line up from bottom: “ $s - k$ ” should be “ $s = k$ ”.

—Nobuhisa Fujinami

P. 188, 6th line up from bottom: The phrase “divide by 7” (within quotes) should be “unsigned divide by 7” (within quotes).

—Nobuhisa Fujinami

P. 193, 13th line from bottom: The line “with respect to ... so they form” should be “of dividing the number above it into the number two rows above it, so they form”.

—Nobuhisa Fujinami

P. 195 line 19: Change the phrase “in the domain of modular arithmetic on integers” to “modulo any power of 2” (retain the exclamation point).

P. 197, after the second paragraph (just before the section “Sample Multiplicative Inverses), insert the following paragraph:

The “Newton method” described here applies only when (1) the modulus is an integral power of some number  $a$ , and (2) the multiplicative inverse of  $d$  modulo  $a$  is known and is used for the starting point  $x_0$ . It works particularly well for  $a = 2$ , because then the multiplicative inverse of any (odd) number  $d$  modulo 2 is known immediately—it is 1.

P. 199, 3rd line from bottom: “x’ 028F5C28 ’” should be “0x028F5C28” (i.e., replace the x’ and the final ’ with 0x in front of the number).

—Nobuhisa Fujinami

P. 207 line 10 in Figure 11–2: “ $x = 5$ ” should be “ $s = 5$ ”.

—Bob Bradley

P. 212 Figure 11–5: replace the entire code with the code shown below. This is necessary to make the remarks about a 64-bit version be correct.

```
int icbrt(unsigned x) {
    int s;
    unsigned y, b;

    y = 0;
    for (s = 30; s >= 0; s = s - 3) {
        y = 2*y;
        b = (3*y*(y + 1) + 1) << s;
        if (x >= b) {
            x = x - b;
            y = y + 1;
        }
    }
    return y;
}
```

P. 215: Delete the fourth bullet and its displayed formula (“It preserves the mathematical identity...”, as it doesn’t make a lot of sense.

—Donald E. Knuth

P. 250: The title of Figure 14–7 should be “Logic circuit for computing  $(x, y)$  from  $s$ .”

P. 284 line 9: After “e.g.,” insert “assuming the Riemann Hypothesis,”. And in line 10, change “integer  $\geq 3$ ” to “real number  $\geq 2.106$ ”.

P. 303: Change the first index heading under P from “parallel prefix operation” to “parallel prefix and suffix operations.”

P. 305: Just before the index entry for space-filling curves, insert the entry “snoob, 14”.

### Non-substantive errors (typographical etc.)

P. xiii 3rd paragraph: Change “ADA” to “Ada”.

—Mitsugu Suzuki

P. xiv: Please add at the end of the preface, in a box positioned on the left:

See [www.HackersDelight.org](http://www.HackersDelight.org)  
for additional material related  
to this book.

P. 4 lines 8, 14, and 18: The left and right parentheses, and the semicolons in line 18, should be in the “code” font (same font as the words `while` and `for`).

P. 16, 6th line up from bottom: Line should be right-justified.

P. 21, 2nd line up from bottom: “zeros” should be “0’s”.

P. 23, 8th line up from bottom: Commas should be closer to less-than-or-equal sign (two places).

P. 35, bottom line: Probably should not have a period.

P. 38: Second paragraph (“This computes...”) should not be indented.

P. 38: Fourth paragraph, “RISC” should be “RS” (so it reads “IBM RS/6000”).

P. 43, 9th line up from the bottom: The colon after “below” should be a period.

P. 44 line 3: The colon after “formula” should be a period.

P. 68 line 13: The period after “multiple of 3”) should be before the parenthesis.

P. 84, first formula: The “1” should be in boldface.

P. 86, 5th line of the program in Figure 5–16, for consistency of style there should be a space between “while” and “( ”.

P. 101 paragraph 3: Replace the phrase “A small improvement results on most machines ...” with “A small improvement may result on some machines ....”

P. 101, in the equation four lines up from the bottom, the equal sign should be a left arrow ( $\leftarrow$ ).

P. 189 and 190: In Tables 10–1 and 10–2, the vertical line near the right, between the “a” and “s” columns, should be shortened a little so it extends up only as high as the vertical line to its left. And in Table 10–1, the horizontal line under “Unsigned” should be extended all the way to the right edge of the table (as it is in Table 10–2).

P. 194, bottom: For consistency, the “x2” should not be enclosed in parentheses, the statement should be “`return x2;`”.

- P. 203, first displayed formula: The dot over the “*a*” should not be there.
- P. 245 (Figure 14–4): In lines 4, 26, and 30, variable “*i*” should be changed to “*s*” (for consistency with using *s* for length or distance in other places in this chapter).
- Mitsugu Suzuki
- P. 246-255: All the table headings in Chapter 14 should have initial caps.
- P. 266, 5th line below the figure: change “inverse” to “reciprocal”.
- P. 293: In reference [Ken], “RS/6000” should be “IBM RS/6000”.
- P. 294: In reference [NZM], “Fifth Edition” should be in italics.
- P. 301 (index): Delete the entry “Jensen, Eric, 87”. Also, if it can be squeezed in easily, add the entry “IDIM, 37”.