

# List of Typographical Errors

## Theory of Computation: A Gentle Introduction

### by Efim Kinber and Carl Smith

Page *xvi*, 7 lines from the bottom, change “imporved” to “improved”.

*Discovered by Mir Abdul Tawab Wakil, University of Maryland*

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Page 4, second line from the bottom. Change “as a” to “and a”

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Page 5, last paragraph. Include 5 in the set of primes less than 10 (4 occurrences).

*Discovered by Matthew Kretchmar, Denison University*

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Page 5, second line from the bottom. Change “like the” to “like  $E$ , the”

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Page 6, 6 lines from the bottom, change “subset” to “ $\subseteq$ ”

*Discovered by Mir Abdul Tawab Wakil, University of Maryland*

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Page 7, just before the last paragraph starting “There are several” insert “Our examples of relation are all *binary* in that the involve relations over pair of sets. Certainly the definition includes relations over triples, quadruples, etc., of sets. Consider a phone book with listing including name address and phone number. A possible relation over this triple might be all the people living at street address under 100 and phone numbers starting with the prefix 234.”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 7, 2nd line from the bottom, change “that a relation may” to “that a binary relation may”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 8, 2nd line from the top, change “ $R$ ” to “ $\hat{R}$ ”

*Discovered by Mir Abdul Tawab Wakil, University of Maryland*

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Page 8, before Figure 1.1, Replace the paragraph before Figure 1.1 with: Suppose  $R$  is a relation over a pair of sets  $S$  and  $T$  such that for each  $a \in S$  there is at most one  $b \in T$  such that  $(a, b) \in R$ . Thus we say that  $R$  is a **function**. We will use the more familiar notation  $f : S \rightarrow T$  to indicate a function that takes inputs from the set  $S$  and returns elements from the set  $T$ . More formally,  $f \subseteq S \times T$  and for each  $x \in S$  there is at most one  $y \in T$  such that  $f(x) = y$ , that is,  $(x, y)$  is in the relation. See Figure 1.1.

*Discovered by Joseph Austin, St. Augustine's College*

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Page 8, just after Figure 1.1, replace “from  $R$  to  $S$ ” with “from  $S$  to  $T$ ” in two places and replace “We call the set  $R$ ” with “We call the set  $S$ ”.

*Discovered by Joseph Austin, St. Augustine's College*

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Page 8, third line from the bottom. Change the sentence starting “A function  $f$  is one-to-one” to “A function  $f$  is one-to-one and onto, also called a **bijection**, if for any  $x \in \text{Dom}(f)$  and  $y \in \text{Dom}(f)$  if  $x \neq y$  then  $f(x) \neq f(y)$  and for each  $y$  in the range of  $f$ , there is an  $x \in \text{Dom}(f)$  with  $f(x) = y$ .”

*Discovered by Robert Sloan, University of Illinois at Chicago and Roberta Sabin, Loyola College*

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Page 9, Exercise 1.2.c, the bar over the left hand set should extend over the entire set.

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Page 18, Line 3 below Figure 2.6, change “is any element” through the rest of the sentence to “is a pair of a state and a string.”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 22, 5th line from the bottom, change “labeled with an  $e$ ” to “labeled with either a  $b$  or an  $e$ ”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 25, just above Figure 2.15, change “connects a state in  $Q$  with” to “connects a state in  $S$  with”.

*Discovered by Judith Newton, Thiel College*

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Page 25, just above Figure 2.15, change the six occurrences of “ $S$ ” to “ $U$ ” including the one in Figure 2.15. Make the same change 11 times on page 26 (including in Figure 2.12 and three times in Figure 2.17). Also change “ $s_1, \dots, s_n$ ” to “ $u_1, \dots, u_n$ ” in Figure 2.15 on page 25, in Figures 2.16 and 2.17 on page 26 and four times in the first complete paragraph on page 27.

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 26, change three occurrences (including one in Figure 2.17) of “ $P'$ ” to “ $P$ ”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 29, in Figure 2.21, change “ $\{\emptyset\}$ ” to “ $\emptyset$ ”.

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 29, line 1, change “deterministic” to “deterministic”.

*Discovered by Mir Abdul Tawab Wakil, University of Maryland*

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Page 29, just after “(see Figure 2.23)” add the sentences: Note that the algorithm applied to the automaton of Figure 2.22 does not give exactly the automaton of Figure 2.23. The algorithm will produce several redundant states after the favorable one. These have been suppressed from Figure 2.23.

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 29, Change the last 3 sentences of section 2.3 (starting with “This problem”) to: This problem can be resolved by a more clever design of the underlying nondeterministic finite automaton. For these cases, consider a nondeterministic finite automaton where every state (except the initial and the favorable ones) has exactly two arrows coming out of it, one labeled by  $e$ . It turns out that the conversion algorithm applied to such a nondeterministic finite automaton produces a deterministic finite automaton that has limited branching and, thus, results in an efficient computer program.

*Discovered by Eric Allender, Rutgers University*

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Page 33, lines 4 and 5, change “favorable state of  $L$  to the initial state of  $M$ ” to “favorable state of  $A$  to the initial state of  $B$ ”

*Discovered by Ian Lotinsky, University of Maryland*

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Page 34, line 4, change **regular langauge** to **regular language**

*Discovered by Matthew Lockner, University of Northern Iowa*

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Page 40, in Algorithm 2.4.1, in the first line, change “ $j$  may be equal  $k$ ” to “ $j$  may equal  $k$ ”

*Discovered by Phil Kirlin, University of Maryland*

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Page 40, in Algorithm 2.4.1, in the first line of the **for** loop, replace “for every pair of nodes  $j$  and  $k$ ” with “for every pair of nodes  $j$  and  $k$  different from  $i$ ”

*Discovered by Walter Beck, University of Northern Iowa*

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Page 41, in Figure 2.39, Steps (1) and (2), change the four (4) occurrences of  $l_{i,j}$  to  $l_{i,k}$ .

*Discovered by Edwin Rijkssen, Hogeschool Amsterdam*

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Page 42, just after Figure 2.42, change “single loop labeled  $abb \cup bb$ ” to “single loop labeled  $bab \cup bb$ ” and in the next paragraph, change “expression is  $ab(abb \cup bb)^*a$ .” to “expression is  $ab(bab \cup bb)^*a$ .”

*Discovered by Jacques Cohen, Brandeis University*

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Page 45, 2 lines Example 2.5.2, change “plays vital” to “plays a vital”

*Discovered by Mir Abdul Tawab Wakil, University of Maryland*

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Page 47, Algorithm 2.6.1, change the second to last sentence that starts “Note that the length” to “Note that the length of every path being observed, including  $e$  transitions, is at most  $n|w|$ , where  $n$  is the number of states. Hence, only paths bounded by this length need be examined.”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 48, second paragraph, line 6, change “any positive integer  $m$ ” to “any positive integer  $n$ ”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 51, Algorithm 2.7.1, change “ $n = 0, 1, 2, \dots$ ” to “ $n = 1, 2, 3, \dots$ ”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 51, last line, change “contains a favorable state” to “contains favorable states”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 54, Exercise 2.1 a, change “accepted” to “accepted.”

*Discovered by Phil Kirlin, University of Maryland*

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Page 54, Exercise 2.1 b, change “and determine if it” to “and determine if it is accepted; also, determine if the automaton”

*Discovered by Judy Goldsmith, University of Kentucky*

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Page 55, Exercise 2.4, change “the stings of length” to “the strings over the alphabet  $\{a, b\}$  of length”

*Discovered by Aaron Elkiss, University of Maryland*

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Page 55, Exercise 2.5, change “number of  $a$ ’s in  $w \dots y \bmod n$ .” to “number of  $a$ ’s in  $w$  is congruent to  $x \bmod m$ , and the number of  $b$ ’s in  $w$  is congruent to  $y \bmod n$ .”

*Discovered by Judy Goldsmith, University of Kentucky*

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Page 55, Exercise 2.6a, change “ $abab$ . and  $aabaab$ ” to “ $abab$  and  $aabaab$ .”

*Discovered by Phil Kirlin, University of Maryland*

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Page 57, Exercise 2.8, The transition from state  $r$  to state  $t$  should be labeled  $a, b$ .  
*Discovered by John Sloan, Western Washington University*

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Page 60, in 2.16*i*. Eliminate the parenthetical remark.  
*Discovered by Robert Sloan, University of Illinois at Chicago and Anthony Bucci, Brandeis University*

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Page 64, in 2.27*a*. Change “a substring” to “a repeated nonempty substring”  
*Discovered by Robert Sloan, University of Illinois at Chicago*

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Page 66, Exercise 2.34.c. Remove the arrow from node  $r$  to node  $p$ , and its associated label.  
*Discovered by Richard Croft, Eastern Oregon University*

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Page 69, line -5, change “set or rules” to “set of rules”  
*Discovered by Katsuhiko Kakehi, Waseda University*

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Page 71, Definition 3.1.1, there is an extra space before the close parenthesis in the third bulleted item.  
*Discovered by Ian Lotinsky, University of Maryland*

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Page 71, line -12, there is an extra space before the period after “sentential forms”.  
*Discovered by Ian Lotinsky, University of Maryland*

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Page 73, Example 3.1.4, there are some spacing problems around the brace before “big”.  
*Discovered by Ian Lotinsky, University of Maryland*

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Page 75, Just before the end of Example 3.1.5, change “(See Exercise 3.12)” to “(See Exercise 3.10)”  
*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 75. The rule “ $E \rightarrow u$ ” needs to be added to Example 3.1.6.

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Page 75. The rule  $S \rightarrow S\mathbf{while}(C)\{S\}S$ ; should be  $S \rightarrow S\mathbf{while}(C)\{S\}; S$

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Page 77, line 2, change “Every derivation tree” to “Every parse tree”  
*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 79, line 5 of section 3.3, change “any transition  $\delta(a, s)$ ” to “any transition  $\delta(s, a)$ ”  
*Discovered by Eng Tan, Thiel College*

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Page 81, line -2, change “character onto the top” to “character  $a$  onto the top”  
*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 83, transition (2) at the top needs a comma, change “)(” to “),(”  
*Discovered by Ian Lotinsky, University of Maryland*

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Page 86, replace action item 2 of the proof (starting “If the topmost symbol on the stack is a terminal”) with “If the topmost symbol on the stack is a terminal, say  $a$ , then only move the head to the right and pop the stack if the current symbol matches the top of the stack; otherwise,  $A$  gets stuck.”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 87, Figure 3.6, in the first line of the table, change  $s_0$  to  $s$ .  
*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 87, Figure 3.6, delete the 7th line of the table.  
*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 87, Delete the sentence “Otherwise, its operation is deterministic.” just prior to Figure 3.6.

*Discovered by Robert Sloan, University of Illinois at Chicago*

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Page 88, line 3, change “)(” to “),(”  
*Discovered by Ian Lotinsky, University of Maryland*

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Page 88, Change two occurrences of “ $A$ ” to “ $M$ ” in the statement of Theorem 3.4.2.  
*Discovered by Mike Slattery, Marquette University*

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Page 88, Replace the sentence starting 7 lines from the bottom of the second paragraph of the proof of Theorem 3.4.2 (starting “Now, every transition” ending with “.and, ”) by “Now, every transition  $((s_0, a, e), (q, \beta)) \in \Delta$  is replaced by the set of transitions  $((s_0, a, t), (q, \beta t))$  for every symbol  $t \in \Gamma \cup \{\triangleleft\}$ ”

*Discovered by Eric Allender, Rutgers University*

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Page 88, 9 lines from the bottom, change “ $L(A)$ ” to “ $L(M)$ ”.  
*Discovered by Ivan Grimm, Thiel College*

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Page 88, last sentence (continuing on page 99) Starting with “For example”, replace the entire sentence with “For example, there may be no rule with left hand side  $[q, B_1, q_1]$ , since there was no corresponding transition  $((q, c, B_1), (q_1, \gamma))$  in  $\Delta$ ”.

*Discovered by Katsuhiko Kakehi, Waseda University*

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Page 90, Rule 2, change “)(” to “),(”

*Discovered by Ian Lotinsky, University of Maryland*

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Page 90, line -3, change “)(” to “),(”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 90, item 1, change “For every  $s \in Q$ , the rule” to “The rule”

*Discovered by Judy Goldsmith, University of Kentucky*

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Page 91, line 6, change “ $L(M) = L(A)$ ” to “ $L(M) = L(G)$ ”

*Discovered by Mike Slattery, Marquette University*

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Page 91, the sentence just before Theorem 2.4.4 needs a period

*Discovered by Mir Abdul Tawab Wakil, University of Maryland*

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Page 93, in Example 3.5.1, change “ $\{a, b\}^* - \{a, b\}^* aaabbb\{a, b\}^*$ ” to “ $\{a, b\}^* - aaabbb$ ”

*Discovered by Judy Goldsmith, University of Kentucky*

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Page 95, Insert “We can assume that  $f(G) > 1$ .” at the beginning of the proof of Lemma 3.6.2. Also, replace “leaves” by “nodes” in the third, second to last and last lines of the proof.

*Discovered by Mike Slattery, Marquette University*

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Page 97, 6 lines from the bottom, change “Consider the string  $uxy$ ” to “Consider the string  $uxz$ ”

*Discovered by Eric Allender, Rutgers University*

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Page 98, line -11, change “?.” to “?”

*Discovered by Ian Lotinsky, University of Maryland*

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Page 99, line 11. “that” should be “than”

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Page 100, line 2, change “if an only” to “if an only if”

*Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology*

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Page 102. Eliminate rule “ $B \rightarrow ab$ ” (the last rule on the page)

Page 103. Add the rule  $S \rightarrow AX_{Ca}$  to the list of rules created by Algorithm 3.7.3.

Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology

Page 104, In part 2 of the statement of Lemma 3.7.3, remove the comma before “is infinite”

Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology

Page 107, line 2 of the proof of Theorem 3.8.1, change “empty store” to “empty stack”

Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology

Page 110, Exercise 3.4. Change “Alter the grammar in Example 3.1.3” to “Alter the grammar in Example 3.1.3, using the same alphabets,”

Page 110, Exercise 3.5. Change “context free-grammars” to “context-free grammars”

Discovered by Mir Abdul Tawab Wakil, University of Maryland

Page 114, Exercise 3.28, change “pushdown automata” to “deterministic pushdown automata”. (This exercise should be moved to section 3.8)

Discovered by Bala Kalyanasundaram, Georgetown University

Page 114, Exercise 3.28, change “Example 3.4.1” to “Example 3.1.1”

Discovered by Anthony Bucci, Brandeis University

Page 115, in exercise 3.31 change “ $\alpha \in \Sigma \times NT$ ” to “ $\alpha \in \Sigma NT$ ”

Discovered by Eric Allender, Rutgers University

Page 116, in exercise 3.38d, the parenthetical remark should be removed.

Discovered by Eric Allender, Rutgers University

Page 125, Example 4.1.1, transition 3, change “)))” to “))”

Discovered by Rudolf Fleischer, The Hong Kong University of Science and Technology

Page 125, second to last paragraph, change “**yields** a configuration  $C_2 = (p, u_1bv_1)$  in one step of computation” to “**yields in one step** of computation a configuration  $C_2 = (p, u_1bv_1)$ ”

Discovered by Robert Sloan, University of Illinois at Chicago

Page 129, second line of Example 4.1.3 change “containing nonblank symbols.” to “con-



taining only nonblank symbols.”

*Discovered by Roberta Sabin, Loyola College*

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Page 131, in Figure 4.10, the arrow (labeled  $\square$ ), and the label, should be eliminated.

*Discovered by Mike Slattery, Marquette University*

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Page 140, in Figure 4.16, Change the cell number “23” to “24” and then cell number “22” to “23”.

*Discovered by Eli Geller, Brandeis University*

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Page 143, first sentence, second paragraph. Replace “practically equivalent to” with “essentially”

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Page 144, third to last paragraph (starting “Now suppose”), change the 2 occurrences of “5” to “4” and the 3 occurrences of “8” to “7”.

*Discovered by Mike Slattery, Marquette University*

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Page 146, line 2. Change “smaller than” to “no greater than”

*Discovered by Walter Beck, University of Northern Iowa*

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Page 147, last line. Remove the last word “as”

*Discovered by Walter Beck, University of Northern Iowa*

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Page 162. In the first sentence of section 5.3, change “domain of any subset” to “domain of any subset”.

*Discovered by Matthew Lockner, University of Northern Iowa*

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Page 166. The proof of Theorem 5.3.2 is correct as written, but some further remarks in the second paragraph may aid understanding. Specifically, in the fourth sentence, change “This means that  $\langle M_0 \rangle$  is in  $\overline{H_0}$ .” to “Since we have assumed  $\overline{H_0}$  is semidecidable, this means that  $\langle M_0 \rangle$  is in  $\overline{H_0}$ .” Change the seventh sentence “This means that  $\langle M_0 \rangle \dots$ ” to “This means, by the definition of  $\langle M_0 \rangle$ , that  $\langle M_0 \rangle \dots$ ”

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Page 169. In the second paragraph of the proof of Theorem 5.4.1, change the sentence “Let  $HALT$  be the halting set from the previous section.” to “Let  $H_0$  be the halting set from the proof of Theorem 5.3.2.” Also, change all occurrences of “ $HALT$ ” to “ $H_0$ ” in the remainder of the proof of Theorem 5.4.1.

*Discovered by Robert Sloan, University of Illinois at Chicago*

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Page 170. In the fourth sentence of the paragraph in the middle of the page (starting “Since”) change “and that are not in  $K_3$ ” to “and programs that are not  $K_3$ ”

*Discovered by Judy Goldsmith, University of Kentucky*

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Page 170. Add “in one step” to the end of the description of property  $M_4$  at the bottom of the page.

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Page 171, line 1. “a decision algorithms” should be “decision algorithms”

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Page 172, Exercise 5.3.b. Change “the blank tape” to “input  $a^n$ ”.

*Discovered by Eric Allender, Rutgers University*

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Page 172, Exercise 5.3.c. Change “proved in 2) and 1)” to “proved in a) and b)”.

*Discovered by Eric Allender, Rutgers University*

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Page 173, Exercise 5.6. Add sentence before a) saying “Assume some fixed alphabet for all subparts of this exercise.”

*Discovered by Judy Goldsmith, University of Kentucky*

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Page 177, The Class P. The  $\mathcal{P}$  is in the wrong font.

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Page 179, on the second to last line, change “Let  $n$  be the number” to “Let  $n - 1$  be the number” and on the next line change “ $i_k$ ” to “ $i_n$ ” and “ $k \leq n$ ” to “ $i_1 = i_n$ .”

*Discovered by Mike Slattery, Marquette University*

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Page 180, line 4 after Figure 6.1, change “ $i_k$ ” to “ $i_n$ ” and “ $k \leq n$ ” to “ $i_1 = i_n$ .”

*Discovered by Mike Slattery, Marquette University*

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Page 182, in the definition of  $L$ , change “ $2^{|w|}$  steps” to “ $2^{|\langle M \rangle|}$  steps”.

*Discovered by Gabe Werczberger, Rutgers University*

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Page 190, line 6, change “ $(x^2)^3 = x^5$ ” to “ $(x^2)^3 = x^6$ ”

*Discovered by Mike Slattery, Marquette University*

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Page 191 in the display 9 lines from the bottom, change the last clause  $(\neg y_{k-4} \vee l_{k-3} \vee l_k)$  to  $(\neg y_{k-3} \vee l_{k-1} \vee l_k)$

*Discovered by Mike Slattery, Marquette University*

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Page 192, line 5 change “Then  $(y_{i-2} \vee l_i \vee y_{i-1})$  is true” to “Then  $(\neg y_{i-2} \vee l_i \vee y_{i-1})$  is true”

*Discovered by Mike Slattery, Marquette University*

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Page 192, line 6 change “ $j > i - 2$ ” to “ $j > i - 1$ .”

*Discovered by Mike Slattery, Marquette University*

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Page 205, eliminate the index entry for “palinrome” and add page 110 to the entry for “palindrome”