Errata

March 6, 1999

1 Exercise numbering

There were some errors in the exercise numbering so some pairs of exercises are numbered identically. You may want to include the page number if you assign any of them. Exercises will be renumbered as follows in the second printing and in the instructor's manual.

Pages 64–65 The exercises should be numbered 0.6-24 through 0.6-30.

Page 139 The exercises should be numbered 2.7-2 through 2.7-5.

Page 194 The exercises should be numbered 3.3-10 through 3.3-12.

Page 453 The exercises should be numbered 7.1-7 and 7.1-8.

2 Other errata

Page 5 In lines 6–8, interchange the words "row" and "column" (3 changes).

Page 29 In the last line before the footnote, change "usually" to "often"

Page 30 In line 4, insert the word "nonempty" before "finite"

Page 31 According to Kleene's obituary in the *New York Times*, his name was pronounced CLAY-nee.

Page 57 In Example 0.46, $\{10, \ldots, 1000\}$ should be $\{0, \ldots, 1000\}$ (because A_i could be $\emptyset$).

Page 70 Figure 1.1 should have SCANb/EMPTY instead of b/EMPTY on the transition $2 \rightarrow 4$.

Pages 70, 145, 146 Figures 1.1, 2.10, and 2.11 should contain a loop on state 4 labeled with SCANa, SCANb, and SCAN# in order to exhaust the input before rejecting.

Page 84 The states in Figure 1.10 should be labeled as in the solution to Exercise 2.7-1.

Page 94 The transition from 1 to 2 should be labelled SCAN# / [PRINT#]. (Otherwise the program jams on input #).

Page 98–99 The program in Figure 1.17 refers to $\mathrm{MEM}[0]$ and $\mathrm{MEM}[1]$. As we defined RAMs, memory indices must be registers rather than constants. The program should start with

$$\mathrm{R}_a := 1; \mathrm{MEM}[\mathrm{R}_a] := \mathrm{R}_c; \mathrm{R}_a := 0; \mathrm{MEM}[\mathrm{R}_a] := \mathrm{R}_b.$$

The program should end with

$$\mathrm{R}_b := \mathrm{MEM}[\mathrm{R}_c]; \mathrm{R}_c := 1; \mathrm{R}_c := \mathrm{MEM}[\mathrm{R}_c].$$

Add two extra states; renumber in the figure and in Example 1.14.

Page 102 Insert before the last sentence of Example 1.16:

The label "NOOP" on an edge indicates that no operations are performed on the input or stack when traversing that edge.

Page 123 In Table 2.1, we say that the repertory of a control is $Q \times Q$. But the repertory is $\{\{(i,j)\} : i \in Q \text{ and } j \in Q\}$, whereas $Q \times Q$ is $\{(i,j) : i \in Q \text{ and } j \in Q\}$, so they are technically different.

Page 129 The arc from state 10 to itself should have only one arrowhead, like the arcs on states 0, 5, 15, and 20.

Page 142 In the last line, replace "all computations of the program on x are blocked or infinite" by "the program must block or run forever on input x"

Pages 145, 146 Figures 2.10 and 2.11 are missing SCAN # on the transition $2 \to 4$.

Pages 164–165 ya should be ay, 3 times on page 164 and twice in Figure 3.9 (because scan looks at the left end of a string).

Page 171 The reference to Figure 3.2.1 should be to Figure 3.15.

Page 174 On the next to last line, $(\nu \to 3, \text{NOOP}, \text{INC})$ should be $(\nu \to 2, \text{NOOP}, \text{INC})$

Page 190 In Figure 3.29, the top and bottom circles should be smaller than the other circles.

Page 190 In the last line, delete the word "a"

Pages 198–201, 213 In Figures 3.36, 3.38, 3.39, and 3.47 and in the unnumbered figure on page 200, all circles that do not contain the letter q should be smaller than the other circles.

Page 201 In Figure 3.39, the arc labeled EOF going down from state q_1 should be labeled $\mathtt{z} \to \mathtt{z}$.

Page 203 The reference to Section 5.4.1 should be to Section 4.1.

Page 207 In the figure caption, the reference to Exercise 3.4-9 should be to Exercise 3.4-8.

Page 209 The statement "P' simulates P" should be "P' is equivalent to P."

Page 214 In Exercise 3.4-19, the reference to Exercise 3.4-9 should be to Exercise 3.4-8.

Page 220 Exercises 4.1-1 and 4.1-2 should be marked with a "$^+$" since they are used later.

Page 247 The reference to Figure 4.5 should be to Figure 4.19.

Page 256 In the second line of Exercise 4.6-6's solution, "X" should be "x."

Page 257 The hint for Exercise 4.6-7 should read: "Construct a DFR whose control set is the set of all monotone Boolean predicates over variables in Q."

Page 262 In Example 4.25, the figure reference should be to Figure 4.24.

Page 266 In Exercise 4.7-12, the figure reference should be to Figure 1.20.

Page 267 In Exercise 4.7-15, replace "prefix equivalent" by "equivalent states."

Page 276 Exercise 4.7-18(c) should refer to the DFA in Figure 4.34. Also, the exercise should be in two parts, since the given program is not a recognizer. First make the program nonblocking. Then minimize the resulting DFR.

Page 288 In the first line of the proof of Corollary 4.46, replace "Let τ_1 and τ_2 be programs" by "Let τ_1 and τ_2 be transfer relations of programs"

Page 294 In order to ensure that $v \neq \Lambda$, the DFA should be standardized by eliminating null instructions and EOF.

Page 305 In the solution to Exercise 4.9-6(b), $f_v^{(p!+1)}$ should be $f_v^{(p!)}$.

Page 336 In the solution to Exercise 5.3-2, G's alphabet includes the symbols for empty set and empty string as well.

Page 338 In the solution to Exercise 5.3-4, the last occurrence of $L(G)$ should be $L(G')$.

Page 346 Replace the last sentence of the proof by: "In part (i), we presented a mapping from derivations to parse trees. That mapping, restricted to leftmost derivations, is the inverse of f. Since f has an inverse, f is one-one and onto."

Page 366 Exercise 5.8-3(h), which says to prove that the set of composites in decimal is not a CFL, is actually an open problem.

Pages 370 The first reference to Figure 5.30 should be Figure 5.13. The second reference to Figure 5.30 should be to Figure 5.14.

Page 371 In the grammar, replace $S \to T$ by the pair of productions

$$\begin{aligned} S &\to \texttt{statement}, \\ S &\to \texttt{if}\, C\, \texttt{then}\, T\, \texttt{else}\, S \end{aligned}$$

for consistency with Figure 5.15.

Page 372 The reference to Figure 5.30 should be to Figure 5.15.

Page 398 In Table 5.5, The column "Initialization, Closure, and Completion" should also contain

In row 3 $S \to S.{+}T, 0$

In row 6 $F \to \texttt{(}S.\texttt{)}, 4$

In row 9 $S \to S.{+}T, 0$

j	$x[j]$	Advance	Initialization, Closure, and Completion
0			$S \to .T, 0$ $S \to .S{+}T, 0$ $T \to .F, 0$ $T \to .T{*}F, 0$ $F \to .\texttt{a}, 0$ $F \to .\texttt{b}, 0$ $F \to .\texttt{(}S\texttt{)}, 0$
1	a	$F \to \texttt{a}., 0$	$T \to F., 0$ $S \to T., 0$ $T \to T.{*}F, 0$ $S \to S.{+}T, 0$
2	+	$S \to S{+}.T, 0$	$T \to .F, 2$ $T \to .T{*}F, 2$ $F \to .\texttt{a}, 2$ $F \to .\texttt{b}, 2$ $F \to .\texttt{(}S\texttt{)}, 2$
3	b	$F \to \texttt{b}., 2$	$T \to F., 2$ $S \to S{+}T., 0$ $T \to T.{*}F, 2$ $S \to S.{+}T, 0$
4	*	$T \to T{*}.F, 2$	$F \to .\texttt{a}, 4$ $F \to .\texttt{b}, 4$ $F \to .\texttt{(}S\texttt{)}, 4$
5	(	$F \to \texttt{(}.S\texttt{)}, 4$	$S \to .T, 5$ $S \to .S{+}T, 5$ $T \to .F, 5$ $T \to .T{*}F, 5$ $F \to .\texttt{a}, 5$ $F \to .\texttt{b}, 5$ $F \to .\texttt{(}S\texttt{)}, 5$
6	a	$F \to \texttt{a}., 5$	$T \to F., 5$ $S \to T., 5$ $T \to T.{*}F, 5$ $S \to S.{+}T, 5$ $F \to \texttt{(}S.\texttt{)}, 4$
7	+	$S \to S{+}.T, 5$	$T \to .F, 7$ $T \to .T{*}F, 7$ $F \to .\texttt{a}, 7$ $F \to .\texttt{b}, 7$ $F \to .\texttt{(}S\texttt{)}, 7$
8	b	$F \to \texttt{b}., 7$	$T \to F., 7$ $T \to T.{*}F, 7$ $S \to S{+}T., 5$ $F \to \texttt{(}S.\texttt{)}, 4$ $S \to S.{+}T, 5$
9	)	$F \to \texttt{(}S\texttt{)}., 4$	$T \to T{*}F., 2$ $S \to S{+}T., 0$ $T \to T.{*}F, 2$ $S \to S.{+}T, 0$

Table 5.5: The records produced by Earley's algorithm when parsing the string `a+b*(a+b)` for the grammar $S \to T \cup S{+}T$, $T \to F \cup T{*}F$, $F \to \texttt{a} \cup \texttt{b} \cup \texttt{(}S\texttt{)}$. Columns 3 and 4 show the sets $\mathrm{RECORD}[j]$ produced by Earley's algorithm. The results of step 3 (Advance) are shown in column 3, and the results of steps 1, 2, and 4 are shown in column 4.

Page 421 In Example 6.17, the reference to Figure 6.17 should be to Figure 6.7.

Pages 452, 453 When simulating a tape by two stacks, the instruction (MOVER, f) in P requires additionally in P' the instructions $(\text{PUSH}c, c \to \sqcup, \text{EMPTY}, f)$, for all $c \in \Gamma$. An extra line should be added to Table 7.1.

Page 453 In Exercise 7.1-7, replace "construct" by "construct informally."

Page 455 In the second paragraph under the heading 3-CMs, in the last line replace "dyadic" by "k-adic."

Page 457 In the 12th line from the bottom, change "dyadic" to "binary"

Page 457 In the last paragraph, replace i by R_b 5 times.

Page 458 In the first paragraph, replace R_b by R_a 3 times, and then replace i by R_a 5 times.

Page 476 In Exercise 7.6-1 change "simulated by" to "equivalent to"

Page 489 In the statement of Theorem 7.27, we should assume that every program in S computes a total recursive function.

Page 495 In the proof of Theorem 7.37, there is no need to replace blocking by infinite loops. Blocking does not count as halting.

Pages 498–508 The name Thue should be spelled without any accent.

Page 513 Relax the definition of $\mathrm{underhang}\,(\cdot)$ to apply to any sequence of pairs, not necessarily beginning with the starting pair.

Pages 521, 523, 526 In Section 7.12, we must permit quantification over variables (but not over functions or predicates). Include inference rules for quantifiers.

In Table 7.5, the quantifier $\forall i$ should be added to each entry that involves the variable i, and the quantifier $\forall j$ should be added to each entry that involves the variable j. In Figure 7.5, the first line should start with $(\forall i)(\forall j)$.

Pages 529, 532, 533, and 534 Change "DSR language" to "DCFL."

Page 538 In the middle of the page, delete the phrase "his proof was being checked as this book went to press"

Pages 540, 541 In Exercise 7.14-4 parts (a–b), g should have m parameters, not n.

Page 560 In both Step 1's, change "run φ_P on input P" to "run P on input P, without producing any output"

Page 567 Replace the proof of Corollary 8.10 by "The proofs we gave of the fixed-point and recursion theorems work for these machine types, because we can effectively convert TMs to them and vice versa."

Pages 569–573 Arithmetic does not contain arbitrary predicate symbols. We need to define Section 7.12's predicates f_q in terms of a number n which encodes a computation. This can be done by guessing a sufficiently large base B and extracting digits. Our statement should be $(\exists n)(\exists B)[H \wedge f_{\text{ACCEPT}}(0,0)]$, where each f_q is defined in terms of n and B. This requires div, mod, addition, multiplication, and exponentation. But it is easy to eliminate exponentiation because x is a power of B iff $(x \bmod y = 0) \Rightarrow (y = 1 \vee y \bmod B = 0)$.

This section needs substantial revisions. I do not recommend covering it in class unless you are comfortable with the proof.

Page 570 Point (vi) should read "A theory of arithmetic is sound if all theorems are true."

Page 576 In Figure 8.1, replace A by B in the edge labels.

Page 589 In the 15th and 16th lines, i should be $i - 1$.

Page 602 The definition of $\mathrm{NTIME}()$ is not quite right. If a string is not accepted, there is no computation at all, hence no shortest computation. So the running time is undefined.

Instead, define running time as the length of the longest partial computation. This is infinite for programs that don't block or halt.

Acknowledgments. Thanks to Robert Bentley, Ray Greenlaw, Jozef Gruska, Emile Roth, Jeffrey Oldham, Vaughan Pratt, and Daniel Leivant for pointing out our mistakes.