Errata: Theory of Computation [1]

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These are errata discovered in the first printing of the text [1]. I would be grateful to receive from readers any further errors, omissions, comments, or suggestions. All contributions will be acknowledged.

p. 12 In Theorem 2.3, only the premise regarding the time lower bound is needed; the space bound is not. The significance of the premise should be explained.

pp. 44ff. Email from Martin Orr:

> I have been studying your book "Theory of Computation", and I believe I have found an error in Lecture 7, on alternation. I was unable to find errata for the book on the web.
>
> You consider the order $\bot \leq 0$, $\bot \leq 1$ on functions $C \to \{0, 1, \bot\}$ (written $\sqsubseteq$) and say "The set of labelings forms a complete lattice under $\sqsubseteq$." This is surely false, because the constant 0 and constant 1 labelings have no upper bound. This invalidates the use of the Knaster-Tarski theorem to construct a labeling ℓ^* of the configurations of an ATM.
>
> Presumably the correct statement would be that the set of labelings is a complete partial order, and use of a fixpoint theorem for CPOs. But Supplementary Lecture A, which contains a proof of the Knaster-Tarski theorem, does not discuss fixpoints for CPOs.

pp. 98, 106 Email from Dmitry Shkurko:

> It seems that there should be p instead of q in $z^{q-1} - 1$ at the page 98 (searching roots of resultant in GP_p). On the page 106 you also implicitly assume high density of prime numbers, i.e. something like $\pi(n)n/\ln n$, because $\pi(n) > \ln n$ is insufficient there.

pp. 107, 108 This argument implicitly uses the Schwartz–Zippel Lemma (Corollary 13.3, p. 79). The reference should be made explicit.

p. 116 $\{0, 1\}^{n^c}$ should be $\{0, 1\}^{c \log n}$ (2 places)

p. 158 Diagram: the first horizontal transition should be labeled $(1, -)$

p. 196 "...we can to show..." should be "...we can show..."

p. 202 second paragraph: need $a = \max 2k + 4, t + 1$ (needed for application of 31.3)

p. 258 In the last two lines, $\vee$ and $\wedge$ are switched

p. 290 Ex. 7: $o(\log n)$ should be $o(n)$

p. 295 Ex. 36: *NLOGSPACE* should be *DLOGSPACE*

p. 309 Ex. 101 and 102 are the same. Ex. 103 is the same as 97.

p. 319 Ex. 2: This is a solution to the wrong problem.

The following errata were communicated by Eric Allender, who has used the text for the course 198:509, *Foundations of Computer Science* at Rutgers:

p. 27 The statement of Lemma 5.2, although true, is misleading. The range of the reduction will be $\{0, 1\}$, but the reduction reduces A to $\{1\}$.

p. 64 The notation $|A \to B|$ 5-7 lines from the bottom of the page, is not clear. The author means to refer to the size of the set of all functions with domain A and co-domain B. That is, one could express this as $|\{f : A \to B\}|$.

p. 85 The discussion in lines 5-10 is correct if one is considering $z_1, \ldots, z_m$ to be a set. But then the right-hand side of the inequality in line 11 should be $\binom{2^m}{m}$, instead of the number of bitstrings of length m^2. This complicates the exposition somewhat. Simple proofs can be found elsewhere, such as on Wikipedia (https://en.wikipedia.org/wiki/Sipser-Lautemann_theorem).

p. 130 Under the list of examples of well-formed terms, the example:
$g(f(g(x), c), f(d, g(y)))$
should be:
$f(f(g(x), c), f(d, g(y)))$

p. 142 7 lines from the bottom of the page, change "and and" to "and".

p. 143 In items (i), (ii), and (iii), the words "a rational number" cannot be justified, unless the k-tuple a (as in the statement of Lemma 22.4) is chosen to be a k-tuple of rational numbers, instead of being a k-tuple of reals, as it is currently stated. When Lemma 22.4 is used, in the proof of Theorem 22.6, one can, in fact, restrict attention to rational numbers.

One way to correct this is as follows. On page 142, change the last 7 lines to the following:

Let σ be an $\equiv^k_{2m^2}$-equivalence class, and τ an $\equiv^{k+1}_m$-equivalence class. Let $a \in \sigma \subseteq \mathbb{R}^k$. We say that τ is *consistent with σ via a* if there exists an $a' \in \mathbb{R}$ such that $(a, a') \in \tau$.

Lemma 22.4 Let $a \in \mathbb{Q}^k$, and let σ be the $\equiv^k_{2m^2}$-equivalence class of a. The set

$$\{(a, f(a)/c) \mid f \in A^k_{2m^2},\ |c| \leq 2m^2,\ c \in \mathbb{Z}\}$$

contains a representative of every $\equiv^{k+1}_m$-equivalence class that is consistent with σ via a.

p. 148 In the first line of the proof of Lemma 23.1, change "sum" to "given expression".

p. 148 Four lines from the bottom of the page, there is an omission (from the preceding expression), saying that for each i in the range $\{1, 2, 3, 4\}$, z_i is in I_n. Since membership in I_n is expressed using $MULT_n$, the word "five" in the last line of page 148 should be replaced by "nine".

p. 149 In the first line of the definition of $INTDIV_n$, replace $I_n(q)$ by $I_n(y)$.

p. 248 4 lines before Theorem 37.1, the text refers to the "least" m-degree. There is a minor technical point here; the class of recursive sets consists of three m-degrees. (1) the empty set. (2) Σ^*, and (3) the degree containing all non-trivial recursive sets.

p. 256 Equation 38.1 would be a bit clearer if it was re-arranged, so that it was more obvious which equalities follow immediately from the definitions.

Further down page 256, item (b) is not written clearly. It should state that if there is any $n < m$ such that running $\varphi_n(n)$ with oracle A_t halts in t steps, where this computation queries the string x, then continue with the simulation.

Also, in item (c), it would help the reader if the text mentioned that when M_m is "crossed off the list", this means that requirement P_m is satisfied.

p. 291 The statement of Exercise 13 is not quite right. The set $\{a\}^*$ is a language, whereas $NSPACE(\log n)$ is a *set* of languages. Thus the intersection is empty. Instead, the intersection should be with the power set of $\{a\}^*$ (or the problem should be stated in terms of the "unary" languages in $DSPACE(\log n)$ and $NSPACE(\log n)$.

p. 306 In problem 90, when definining programs in this language, you also need to describe how input and output are provided. I assume that output should be a tuple of some (but not necessarily all) variables.

pp. 319-322 The statement of Problem 2 talks about k-counter automata, but (much of) the solution talks about k-head DFAs.

p. 341 in lines 4 and 7, all occurrences of k should be n.

p. 397 in reference [103], the correct pages are 304-308.

References

[1] Dexter Kozen. *Theory of Computation.* Springer, New York, 2006.