Communication and Concurrency
ERRATA

Note (by Joachim Parrow): This applies only to the first editions of the book. If your book has a Chapter 5.7 then it is a recent edition where the following has been fixed.

This note lists some errata in my book **Communication and Concurrency** (Prentice Hall 1989). The first section is a list of minor errata; the second section deals with a rather more important correction to Definition 5.8. In the errata the symbol $\longmapsto$ is used to signify replacement, and 'Line -3' means the third line from bottom.

Robin Milner, Edinburgh, November 1990

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9 Line 9: $\{f(l) \ : \ l \in L\} \longmapsto \{l \ : \ f(l) \in L\}$
9 Last line under Action Constructions: Product $\longmapsto$ product
52 Line -2: 1(2) $\longmapsto$ 2(2) Line -1: 1(1) $\longmapsto$ 2(1)
56 Line 4: $E \longmapsto \mathcal{E}$ Line -11: $\sum_{v\in V} E_v \longmapsto \sum_{v\in V} \mathtt{in}_v.E_v$
67 In Exercise 9: Section 3 $\longmapsto$ Sections 3 and 4
76 Line -5: 2(1) $\longmapsto$ 2(2)
80 Line -3: one-to one $\longmapsto$ one-to-one
97 Line 11: $Q - i \longmapsto Q_i$ Line 12: $P'_i = Q'_i[f_i] \longmapsto P'_i \equiv Q'_i[f_i]$
98 Line 11: $P_2|Q' \stackrel{\alpha}{\to} P_2|Q' \longmapsto P_2|Q \stackrel{\alpha}{\to} P_2|Q'$
101 In Exercise 6: Proposition 14 $\longmapsto$ Proposition 12
102 Line -11: $E'_1|E'_2 \longmapsto E'_1|E_2$
102 Lines -10, -8 (four times): $\{P/X\} \longmapsto \{\tilde{P}/\tilde{X}\}$
102 Line -2: X does not occur $\longmapsto$ no $X \in \tilde{X}$ occurs
104 Lines 11, 14, 17 (six times): $R \longmapsto \mathcal{R}$
108 Line -9: (Definition 7) $\longmapsto$ (Definition 5)
119 Line 9: $\backslash c \longmapsto \backslash c_i$
125 In rows (4), (8), (10) and (12) of table: $Mal \longmapsto Mal'$
126 Line -12: $Usem(j) \longmapsto Usetool(j)$
133 Line 9 (excluding diagram): Expansion $\longmapsto$ expansion

135 Line 25: basic the $\longmapsto$ basic
139 Line 15: $2^k b_k \longmapsto 2^{k-1} b_k$
145 Replace line -12 by: Note however that $AB \neq \mathit{Buff}$, since AB is unstable.
147 Line 4 of Exercise 16: *before* $\longmapsto$ *after*
151 Line 7 of proof: $ell \longmapsto \ell$
152 Line 13 (twice): $[S] \longmapsto [f]$
159 Line 14: by Lemma 12 $\longmapsto$ by repeated use of Lemma 12
161 Line -7: $b(c.\mathbf{0} + \tau.\mathbf{0}) \longmapsto b.(c.\mathbf{0} + \tau.\mathbf{0})$
163 Line 2: Q yield $\longmapsto$ yield Q
166 Line 2: 7.11 $\longmapsto$ 7.13
169 Line -9: expressed $\longmapsto$ is expressed
171 Line -16: parallelism $\longmapsto$ parallelism in
173 Line 4: $\mathtt{done} \longmapsto \overline{\mathtt{done}}$
181 Line 1: **L3** $\longmapsto$ **L1**
188 Line 12: Decorated braces should be ( )
189 Line 12: appropriate $\longmapsto$ appropriate for
191 Lines 5 and 9 after Exercise 4: $\overline{\mathtt{d}} \longmapsto \overline{\mathtt{done}}$
206 Line 6: $B' \stackrel{\mathrm{def}}{=} c_1.b.c_2.A' \longmapsto B' \stackrel{\mathrm{def}}{=} c_1.b.c_2.B'$
222 Line 14: $\tilde{Z}_1 = \tilde{X}_1 \cup \tilde{Y}_1 \longmapsto \tilde{Z}_2 = \tilde{X}_2 \cup \tilde{Y}_2$
226 Line -10: $\not\sim P_i \longmapsto \not\sim_{i+1} P_i$
227 Line 5: Proposition 4 $\longmapsto$ Proposition 5
236 Line 5: $\mathit{Ever}(a) \longmapsto \mathit{Ever}(\overline{a})$
237 Last line in diagram: $Q_2 \rightarrow Q_2' \longmapsto Q_2 \stackrel{\alpha}{\rightarrow} Q_2'$
243 Line 5: P, P_1 and P_2 are $\longmapsto$ P is
246 Line 5: injective $\longmapsto$ one-to-one
249 Insert '**Chapter 8**:' at start of line -17.
250 Line -4: Willen $\longmapsto$ Willem
252 Line -17: *for* $\longmapsto$ *of*

This concludes the minor errata. On the next two pages are some amendments necessary to correct a theoretical error in the definition of *bisimulation up to* $\approx$, Definition 5.8.

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viii *Add a new contents line after 5.6:*

111 *Replace Definition 8 and the ensuing three lines by:*

Definition 8 $\mathcal{S}$ is a (*weak*) *bisimulation up to* $\approx$ if $P\mathcal{S}Q$ implies, for all α,

(i) Whenever $P \stackrel{\alpha}{\Rightarrow} P'$ then, for some Q', $Q \stackrel{\widehat{\alpha}}{\Rightarrow} Q'$ and $P' \approx\mathcal{S}\approx Q'$

(ii) Whenever $Q \stackrel{\alpha}{\Rightarrow} Q'$ then, for some P', $P \stackrel{\widehat{\alpha}}{\Rightarrow} P'$ and $P' \approx\mathcal{S}\approx Q'$ ■

Note the use of $\stackrel{\alpha}{\Rightarrow}$, in contrast with $\stackrel{\alpha}{\rightarrow}$ in Definition 5 (see Section 7 below). We now show that, to ensure $P \approx Q$, it is enough that (P, Q) is in some bisimulation up to $\approx$. The crux is the following:

119 *Replace the six lines after the lemma by:*

Using this lemma with Proposition 11, it is easy to show that every α-*descendant* of $Sched(i, X)$ is equivalent to an α-*derivative*. (There are no α-descendants which involve more than two actions.) So, in proving that $\mathcal{S}$ is a bisimulation up to $\approx$, it will suffice to match just the α-derivatives of $Sched(i, X)$, rather than all its α-descendants. Now let us consider these derivatives in turn:

125 *Replace line 6 by:*

$$Jobber \mid Usingh(j) \sim Usingh(j) \mid Jobber$$

Replace lines -6 to -3 by:

Now, to show that $\mathcal{S}$ is a bisimulation up to $\approx$, we shall (as for the Scheduler) match only the α-*derivatives* of *Jobshop* rather than all its α-*descendants*. But here our justification is different, and will be given in Section 7 below. Consider then a few pairs of $\mathcal{S}$:

156 *Replace line 1 by:*

... important. It follows from Proposition 5.12 that $(*)$ makes $\mathcal{S}$

159 *On line 4, and again on line -9, replace* $H(P) \stackrel{\alpha}{\rightarrow} P'$ *by* $H(P) \stackrel{\alpha}{\Rightarrow} P'$

180 *Replace line -15 by:*

is a bisimulation up to $\approx$, by Proposition 5.12. Now

128 *Add a new section, in the blank space:*

5.7 A further technique for bisimulation

A drawback in using the condition of Definition 8, to establish bisimulation up to $\approx$, is that we have to match not just the α-derivatives ($\stackrel{\alpha}{\rightarrow}$) but all the α-descendants ($\stackrel{\alpha}{\Rightarrow}$). This caused no trouble in verifying the scheduler in Section 5.5, because every α-descendant was bisimilar to an α-derivative, so only the latter had to be considered. But in other cases – for example, in verifying the jobshop in Section 5.6 – this property may not hold, or at least may be hard to establish. However, the following proposition shows that it is indeed enough just to match the α-derivatives provided that we demand a stronger form of matching (involving $\sim$ rather than $\approx$ in a critical place); this is what justifies our proof in Section 5.6.

Proposition 12 Let $\mathcal{S}$ be such that $P\mathcal{S}Q$ implies, for all α,

(i) Whenever $P \stackrel{\alpha}{\rightarrow} P'$ then, for some Q', $Q \stackrel{\widehat{\alpha}}{\Rightarrow} Q'$ and $P' \sim\mathcal{S}\approx Q'$

(ii) Whenever $Q \stackrel{\alpha}{\rightarrow} Q'$ then, for some P', $P \stackrel{\widehat{\alpha}}{\Rightarrow} P'$ and $P' \approx\mathcal{S}\sim Q'$

Then $\mathcal{S}$ is a bisimulation up to $\approx$. ■

Thus we have a choice between two conditions – Definition 8 and Proposition 12 – in proving bisimulation up to $\approx$. In Section 6.4 we shall find Proposition 12 more convenient; but in proving Proposition 7.13 we shall find it easier to revert to Definition 8.

Exercise 14 Prove Proposition 12. Also, by letting $\mathcal{S} = \{(\tau.a.\mathbf{0}, \mathbf{0})\}$, find out what goes wrong if we replace $\sim$ by $\approx$ in Proposition 12. (Bisimulation up to $\approx$ was wrongly *defined* in this way, when the book was first printed; many thanks to Gunnar Sjödin and Bengt Jonsson for pointing out the mistake, with the help of this $\mathcal{S}$.) ■