Errata and comments to textbook J.W.S. Liu, "Real-Time Systems"

Prentice Hall, 2000

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- Page 66, Figure 4-3

  Arrow from $J_3(1, 12)$ to $J_7(6, 21)$ should be deleted, because J_3 is *not* an immediate predecessor of J_7. (See also the definition of precedence graphs at page 44.)

- Page 89, Figure 5-4

  Rightmost "$t + 2f$" should be "$t + 3f$"

- Page 89, lines 10–11

  "Because the difference $t' - t$ is at least equal to the greatest common divisor $\gcd(p_i, f)$ of p_i and f ..."

  To prove this claim, consider that, from page 88: "The phase of each periodic task is a nonnegative integer multiple of the frame size". Thus, $t' = \Phi_i + h' \times p_i = h \times f + h' \times p_i$ and $t = h'' \times f$, for some integers h, h', and h''. Therefore, if $g = \gcd(p_i, f)$, then $t' - t = g \times \left(\frac{h \times f}{g} + \frac{h' \times p_i}{g} - \frac{h'' \times f}{g}\right) = g \times h'''$ for some integer h'''. By hypothesis $t' - t > 0$, thus $h''' \geq 1$, therefore $t' - t \geq g$.

- Page 92, line 3 from bottom

  Citation "[RaLe]" should be "[LeRa]"

- Page 93, Figure 5-8(b)

  Label "A_3" outside box should be "A_2"

- Page 93, Figure 5-8(d)

  At bottom-right corner of the figure, the rightmost line inside the gray box should be vertically aligned to the rightmost line inside the gray box of part (c)

- Page 126, lines 6–1 from bottom

  "*A system of independent, preemptable periodic tasks with relative deadlines longer than their periods can be feasibly scheduled on a processor as long as the total utilization is equal to or less than 1.*"

  This corollary states a necessary and sufficient condition for schedulability. The sufficient condition is easy to prove: if the total utilization is not greater than 1, then EDF produces a feasible schedule in which each job completes before the next job in the same task is released, therefore each job satisfies the corresponding deadline.

  The proof of the necessary condition is based on the following reasoning: consider a task having phase 0, period p, deadline $D \geq p$, and execution time e. If the first deadline is satisfied, then $D \geq e$. If the first two deadlines are satisfied, then $D + p \geq 2e$. ... If the first $k+1$ deadlines are satisfied, then $D + k \cdot p \geq (k+1) \cdot e$. Therefore for all $k = 1, 2, \ldots$:

$$\frac{e}{p} < \frac{k+1}{k} \cdot \frac{e}{p} \leq 1 + \frac{D}{k \cdot p} \quad \Rightarrow \quad \frac{e}{p} \leq 1.$$

  To extend the proof to a system with n tasks, let assume that they are in phase and that the claim holds for the first $n-1$ tasks. Then, in order to schedule the last task T_n we have:

$$\left(1 - \sum_{i=1}^{n-1} \frac{e_i}{p_i}\right) \cdot (D_n + k \cdot p_n) \geq (k+1) \cdot e_n$$

  therefore for all $k = 1, 2, \ldots$:

$$\frac{e_n}{p_n} < \left(1 - \sum_{i=1}^{n-1} \frac{e_i}{p_i}\right) \cdot \left(1 + \frac{D_n}{k \cdot p_n}\right) \quad \Rightarrow \quad U \leq 1$$

  Finally, if the tasks are not in phase we can apply the above reasoning to an interval of time starting at the maximum phase among all tasks.

- Page 131, lines 18–19 from top

  "[...] gives us the condition under [...]" should be "[...] gives us a sufficient condition under [...]".

- Page 135, lines 14–20 from top

  These sentences are confusing, as they appear to imply that being released at the same time of all higher priority jobs is a necessary condition for having the worst response time.

  As a matter of fact, this is only a sufficient condition. For example, look at response times in Figure 6-8: job of T_3 released at time 9 has the worst response time $(11 - 9 = 2)$, exactly as the job released at critical instant 0, but no job of T_1 or T_2 has been released at 9.

- Page 147, line 9 from bottom

  "0.85" should be "0.87"

- Page 153, line 4 from bottom

  "0.712" should be "0.721"

- Page 157, first line in formula of Theorem 6.16

  Inside the exponent: "$1/n - 1$" should be "$1/(n - 1)$"

- Page 158, Figure 6-18

  The values in the table for $\delta \geq 2.0$ are wrong. Actually, the values refer to the case $n + 1$ rather than n. For example, the value in the cell labelled $\delta = 4.0$ and $n = 2$ is the real value for $\delta = 4.0$ and $n = 3$

- Page 170, line 2 from bottom

  "18.75" should be "19.8"

- Page 192, line 17 from bottom

  Last occurrence of "T_1" should be "T_2"

- Page 196, line 8 from top

  "kp_k" should be "$k\,p_s$"

- Page 201, line 18 from bottom

  "Theorem 6.5" should be "Theorem 6.11".

- Page 203, line 14 from bottom

  Reference "[GhBa]" is missing from the bibliography. Look for "[GaBa]" entry.

- Page 204, line 1 from top

  In formula, "$\leq$" should be "$<$"

- Page 219, line 14 from bottom

  I think it makes more sense to define "l" as the number of releases and *deadlines* rather than the number of releases and *completions*.

  In fact, jobs are active in between release and deadline times, and a deadline can be later than completion time.

- Page 220, lines 19–20 from bottom

  "is always larger than its" should be "is always larger than or equal to its"

- Page 222, caption of Figure 7-13

  "$T_1 = (4, 0.5)$" should be "$T_1 = (3, 0.5)$"

- Page 223, line 1 from bottom

  "23.5" should be "23"

- Page 252, Figure 7-21

  In the bottom-most timeline (for S_4), "$\Delta_{S,1}$=0.35" should be "$\Delta_{S,1}$=0.6".

  Also: in the whole figure "$\Delta_{S,n}$" should be "$\Delta_{s,n}$" for notation consistency.

- Page 305, line 7 from top

  "and $T_1 =$" should be "and $T_3 =$"

- Page 580, entry [GaBa]

  "[GaBa]" should be "[GhBa]"

  The entry is referred to as "[GhBa]" in text.