Errata for

Calendrical Calculations: Third Edition

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If you find errors not given below or can suggest improvements to the book, please send us the details (email to reingold@iit.edu or hard copy to Edward M. Reingold, Department of Computer Science, Illinois Institute of Technology, 10 West 31st Street, Suite 236, Chicago, IL 60616-3729 U.S.A.). If you have occasion to refer to errors below in corresponding with the authors, please refer to the item by page and line numbers in the book, *not* by item number.

Unless otherwise indicated, line counts used in describing the errata are positive counting down from the first line of text on the page, excluding the header, and negative counting up from the last line of text on the page *including footnote lines*.

Our thanks to all those who pointed out errors or suggested improvements to the text.

The latest version of this document can be obtained from the Web site `http://www.calendarists.com`

SERIOUS ERRORS

The severity of an error is indicated by the red asterisks preceding the error number. No asterisk indicates a note or a trivial error, a single asterisk a more serious error, a double asterisk an even more serious error, and so on. The only serious errors below are: 22, 42.

FRONTMATTER

1. Page xvi: Entries for inverse trigonometric functions should specify the principal values in each case, and the code should be modified to return (and use!) values in that range:

$\arcsin x$	Arc sine	Inverse sine of x, in degrees, in range $[-90°, 90°]$
$\arccos x$	Arc cosine	Inverse cosine of x, in degrees, in range $[0°, 180°]$
$\arctan x$	Arc tangent	Inverse tangent of x, in degrees, in range $(-90°, 90°)$

CHAPTER 1: CALENDAR BASICS

2. Page 5, second line of footnote: Change “calandar” to “calendar”. (Courtesy of Enrico Spinielli, March 12, 2008.)

3. Page 9, line 3 of footnote 7: Delete “an”.

4. Page 11, line −14: Change “Atlcahualo 11” to “Panquetzaliztli 1”. (Courtesy of Enrico Spinielli, June 30, 2008.)

5. Page 11, line −12: Change "Lunag" to "Luang". (Courtesy of Enrico Spinielli, July 28, 2008.)

6. Page 11, line −13: Change "9 Ozomatli" to "11 Atl". (Courtesy of Enrico Spinielli, June 30, 2008.)

7. Page 15, Table 1.2: The Julian date for the Tibetan era is wrong; it should be December 10, 128 B.C.E. (not 127 B.C.E.). (Courtesy of Julian Gilbey, May 21, 2010.)

8. Page 17, line −2: The sentence "In general, $\lceil x \rceil = -\lfloor -x \rfloor$, so for example $\lfloor -\pi \rfloor = -4$." is misplaced; it belongs in line 1 of page 18, just before "For integers...". (Courtesy of Svante Janson, July 12, 2008.)

9. Page 18, equation (1.14): The Lisp definition of `signum` is floating point if the argmument is floating point, so we should define our own version (which is not allowed to replace the built-in definition, so we must call it `sgn` instead):

$$\operatorname{sgn}(y) \stackrel{\text{def}}{=} \begin{cases} -1 & \textbf{if } y < 0 \\ 1 & \textbf{if } y > 0 \\ 0 & \textbf{otherwise} \end{cases} \tag{1.14}$$

10. Page 24, equation (1.37): Our function **angle-from-degrees** does not handle negative angles properly; the usual convention is that all components must be negative if the angle is negative, but the way we wrote it, degrees are negative, but minutes and seconds are positive (the result is equvalent to the correct angle, but peculiar!). (Courtesy of Enrico Spinielli, December 10, 2009.)

11. Page 27, line 17: Change "superfluous term R.D. $0 = 0$" to "superfluous terms $-$R.D. $0 -$ *sunday*"

12. Page 29, line 3: Change $x + 1$ to $x - 1$. (Courtesy of Svante Janson, July 12, 2008.)

13. Page 30, Table 1.3: Change the entry for "On or before d" from $d + \Delta - k$ to d. (Courtesy of Svante Janson, July 12, 2008.)

14. Page 30, line 2 of the Madariaga quotation: Change "Monteçuçuma" to "Moteçuçuma".

15. Page 39, second full paragraph: The theoretical discussion here of how to approximate the year on an arithmetic calendar of a given fixed date, and then refine the approximation, is incorrect and does not correspond to what we actually do in the functions **alt-gregorian-year-from-fixed**, **hebrew-from-fixed**, and **arithmetic-french-from-fixed** (all of which are correct). Here is the correct method of approximation/refinement.

    Let n_0 be the calendar's fixed epoch (R.D. date of the start of year 1), Y its mean year length, **new-year**(i) the fixed starting day of year i, and $\delta = \max_i\{n_0 + (i-1) \times Y - \textbf{new-year}(i)\}$, the maximum number of days that a real year can begin before the mean year does. Assume that the actual year always begins before or simultaneously with the mean year; that is, assume that **new-year**$(i) \le n_0 + (i-1) \times Y$. Assume further that $\delta \le Y$. We first estimate the year of fixed date d to be the mean value $y = \lfloor (d - n_0)/Y \rfloor + 1$. Then, we check if $(d - n_0) \bmod Y \ge Y - \delta$ (d falls in the "twilight zone") and $d \ge$ **new-year**$(y+1)$ (the estimate is actually wrong), in which case the estimate is off by one and the correct year is $y+1$. If the actual new year can begin *after* the mean new year, that is, if it can happen that **new-year**$(i) > n_0 + (i-1) \times Y$, the correct year could be $y-1$, as well as y or $y+1$. If $\delta > Y$, the correct year could be $y+2$. (Courtesy of Svante Janson, July 12, 2008.)

CHAPTER 2: THE GREGORIAN CALENDAR

16. Page 52, **day-number**: Replace (2.25) by

$$\textbf{day-number}\,(g\text{-}date) \stackrel{\text{def}}{=} \tag{2.25}$$

$$\textbf{gregorian-date-difference}\left(\boxed{g\text{-}date_{\textbf{year}} - 1}\;\boxed{\textbf{december}}\;\boxed{31}\,, g\text{-}date\right)$$

(Courtesy of Andy Pepperdine, July 12, 2008.)

17. Page 52, **days-remaining**: Replace (2.26) by

$$\textbf{days-remaining}\,(g\text{-}date) \stackrel{\text{def}}{=} \tag{2.26}$$

$$\textbf{gregorian-date-difference}\left(g\text{-}date, \boxed{g\text{-}date_{\textbf{year}}}\;\boxed{\textbf{december}}\;\boxed{31}\right)$$

(Courtesy of Andy Pepperdine, July 12, 2008.)

CHAPTER 4: THE COPTIC AND ETHIOPIC CALENDARS

18. Page 76, line 3 of the section quote for section 4.3: Change "shits" to "shifts". (Courtesy of Jonathan Leffler, October 9, 2008.)

CHAPTER 5: THE ISO CALENDAR

19. Page 81, line 2: Change "Let s be number" to "Let s be the number". (Courtesy of Julian Gilbey, January 9, 2011.)

CHAPTER 6: THE ISLAMIC CALENDAR

20. Page 85, last line: Change "varyear" to "*year*". (Courtesy of Julian Gilbey, January 9, 2011.)

CHAPTER 7: THE HEBREW CALENDAR

21. Page 109, line 12: Change "Wednesday" to "Sunday". (Courtesy of Julian Gilbey, January 9, 2011.)

*22. Pages 109–110, **possible-hebrew-days**: This is wrong and should be replaced with

$$\textbf{possible-hebrew-days}\,(\textit{h-month}, \textit{h-day}) \stackrel{\text{def}}{=} \textbf{shift-days}\,(\textit{basic} \parallel \textit{extra}, n) \tag{7.44}$$

where

$$\textit{h-date}_0 = \boxed{5 \mid \textbf{nisan} \mid 1}$$

$$\textit{h-year} = \begin{cases} 6 & \textbf{if } \textit{h-month} > \textbf{elul} \\ 5 & \textbf{otherwise} \end{cases}$$

$$\textit{h-date} = \boxed{\textit{h-year} \mid \textit{h-month} \mid \textit{h-day}}$$

$$n = \textbf{fixed-from-hebrew}\,(\textit{h-date}) - \textbf{fixed-from-hebrew}\,(\textit{h-date}_0)$$

$$\textit{basic} = \langle \textbf{tuesday}, \textbf{thursday}, \textbf{saturday} \rangle$$

$$\textit{extra} = \begin{cases} \langle\,\rangle & \textbf{if } \textit{h-month} = \textbf{marheshvan} \text{ and } \textit{h-day} = 30 \\ \langle \textbf{monday}, \textbf{wednesday}, \textbf{friday} \rangle & \textbf{if } \textit{h-month} = \textbf{kislev} \text{ and } \textit{h-day} < 30 \\ \langle \textbf{monday} \rangle & \textbf{if } \textit{h-month} = \textbf{kislev} \text{ and } \textit{h-day} = 30 \\ \langle \textbf{sunday}, \textbf{monday} \rangle & \textbf{if } \textit{h-month} \in \{\textbf{tevet}, \textbf{shevat}\} \\ \langle \textbf{sunday}, \textbf{monday} \rangle & \textbf{if } \textit{h-month} = \textbf{adar} \text{ and } \textit{h-day} < 30 \\ \langle \textbf{sunday} \rangle & \textbf{otherwise} \end{cases}$$

(Courtesy of Julian Gilbey, January 10, 2011.)

CHAPTER 8: THE ECCLESIASTICAL CALENDARS

23. Page 113, line −8: Change "The concern that date of" to "The concern that the date of" (Courtesy of Julian Gilbey, January 9, 2011.)

CHAPTER 9: THE OLD HINDU CALENDARS

24. Page 128, first text line of section 9.3: Change "method which" to "method in which". (Courtesy of Enrico Spinielli, March 12, 2008.)

25. Page 129, line 18: Change "Pausha" to "Pauṣa". (Courtesy of Andy Pepperdine, July 24, 2008.)

CHAPTER 10: THE MAYAN CALENDARS

26. Page 144, formula (10.12): Remove the +364 from the expression for x in **mayan-year-bearer-from-fixed**. (Courtesy of Kai Kuhlmann, November 10, 2012.)

27. Page 146, line −14: Change "Heui" to "Huei". (Courtesy of Andy Pepperdine, August 1, 2008.)

28. Page 146: The table of xihuitl months is a confusion of that used in different parts of Mexico. (Courtesy of Andy Pepperdine, August 1, 2008.)

CHAPTER 12: GENERIC CYCLICAL CALENDARS

29. Page 165, equations (12.14)–(12.18): Add the equation

$$m = \lceil d/M \rceil - 1$$

between (12.16) and (12.17). (Courtesy of Kai Kuhlmann, March 13, 2011.)

30. Page 167, equation (12.42): Change amod to mod.

CHAPTER 13: TIME AND ASTRONOMY

31. Page 173, **arctan**: The function does not protect against the case $x = y = 0$, in which case it should return **bogus**. This function is used in **right-ascension** (in which the troublesome case cannot occur), **precession** (in which it might occur, but is extremely unlikely), and **asr**. These functions should return **bogus** if **arctan** returns **bogus**. (Courtesy of Andy Pepperdine, August 9, 2010.)

32. Page 182, line −11: Change "Chapter 12" to "Chapter 20". (Courtesy of Enrico Spinielli, August 2, 2009.)

33. Page 186, line −8: Change "latitude λ and longitude β" to "latitude β and longitude λ". (Courtesy of Kai Kuhlmann, August 13, 2008.)

34. Page 190, lines −6 and −7: Change ϕ to λ. (Courtesy of Craig Dedo, March 5, 2013.)

35. Page 193, line 1: Change "such as noon midnight" to "such as noon or midnight". (Courtesy of Andy Pepperdine, August 28, 2008.)

36. Page 199, last line: Change "distancefrom" to "distance from". (Courtesy of Enrico Spinielli, March 12, 2008.)

37. Page 215, reference [26]: Add a comma after the authors' names.

CHAPTER 14: THE PERSIAN CALENDAR

38. Page 218, line 4: Change "13.5" to "15.3". (Courtesy of Andy Pepperdine, July 23, 2008.)

39. Page 219, line 2: Change "calendar 1925" to "calendar in 1925". (Courtesy of Enrico Spinielli, March 12, 2008.)

CHAPTER 15: THE BAHÁ'Í CALENDAR

40. Page 236, line −1: Change "Birth of 'Abdu'l-Bahā (also 'Aẓamat 7 = May 23)" to "Day of the Covenant (Qawl 4 = November 26)". (Courtesy of William P. Collins, June 20, 2008.)

CHAPTER 17: THE CHINESE CALENDAR

41. Page 262, line 14: Replace "began on R.D. 45" with "began on R.D. 46, so that day 0 (or, 60) of the cycle is".

*42. Page 262, equation (17.25) **chinese-day-name-on-or-before**: This is wrong and should be replaced with

$$\begin{aligned}&\textbf{chinese-day-name-on-or-before}\\&\qquad(name, date) \stackrel{\text{def}}{=}\end{aligned} \tag{17.25}$$

$$\begin{aligned}&date\\&- \big(\big(date\\&\qquad + \textbf{chinese-name-difference}\\&\qquad\quad \big(name,\\&\qquad\quad\ \textbf{chinese-name-of-day}\,(0)\big)\big) \mod 60\big)\end{aligned}$$

43. Page 268, lines −5 and −4: The ending year for the Meiji era should be 1912, not 1911; the ending year for the Keio era should be 1868, not 1866. (Courtesy of Peter Zilahy Ingerman, February 15, 2008.)

CHAPTER 18: THE MODERN HINDU CALENDARS

44. Page 278, line −8: Change "Mārgaśīrsha" to "Mārgaśīrṣa".

45. Page 278, line −15: Change "Mārgaśīra" to "Mārgaśīrṣa". (Courtesy of Andy Pepperdine, October 1, 2008.)

46. Page 289, line −4: Change C.E. to B.C.E. (Courtesy of Andy Pepperdine, November 28, 2012.)

47. Page 306, line 20. Change "Mārgaśīra" to "Mārgaśīrṣa".

48. Page 309, line −6: Change **hindu-lunar-day-at-or-after**$(d, (n + 1)/2)$ to **hindu-lunar-day-at-or-after**$((n + 1)/2, d)$. (Courtesy of Andy Pepperdine, October 23, 2008.)

49. Page 312, line 15: Change *kaṛana* to *karaṇa*. (Courtesy of Andy Pepperdine, October 21, 2008.)

CHAPTER 19: THE TIBETAN CALENDAR

50. Page 315, first two lines of the first paragraph: Change "*Phugpa* or *Phukluk*" to "*Phug-lugs* (or *Phug-pa* or *Phukluk*)". (Courtesy of Dieter Schuh, August 18, 2009.)

CHAPTER 20: ASTRONOMICAL LUNAR CALENDARS

51. Page 326, line 7: Table 8.1 is on page 120, not page 119. (Courtesy of Steve Ward, July 27, 2008.)

52. Page 326, **visible-crescent**: Note that the code is not intended for high altitudes and polar regions. (Courtesy of Andy Pepperdine, September 15, 2008.)

53. Page 327, **visible-crescent**: The function **visible-crescent** checks visibility on the eve of *date*, so we want:

$$\textbf{phasis-on-or-after}\,(date, location) \stackrel{\text{def}}{=} \tag{20.4}$$

$$\underset{d \geq \tau}{\text{MIN}} \left\{ \textbf{visible-crescent}\,(d, location) \right\}$$

where

$$mean = date - \left\lfloor \frac{\textbf{lunar-phase}\,(date + 1)}{360^\circ} \times \textbf{mean-synodic-month} \right\rfloor$$

$$\tau = \begin{cases} date & \textbf{if } date - mean \leq 3 \text{ and} \\ & \quad \text{not } \textbf{visible-crescent} \\ & \quad\quad (date, location) \\ mean + 29 & \textbf{otherwise} \end{cases}$$

54. Page 328, line 4: Change "Finally, once" to "Finally, one". (Courtesy of Enrico Spinielli, March 12, 2008.)

55. Page 328, line 5: Delete the extra word "search". (Courtesy of Irv Bromberg, April 17, 2010.)

56. Pages 328–331, sections 20.3 and 20.4: Our code allows for a 31st day of an Islamic or Hebrew month, which is longer than allowed by the rules. Instead, that day would be the first of the following month—were the moon actually observed when the simple criterion we are using says it becomes visible. This shift can cascade for several months. We did not take this into account, since there is no way to determine when in fact the new moons are actually observed, and which months are affected.

BACKMATTER

57. Page 337, *armenian-day*: The range should be $1 \ldots 30$. (Courtesy of Uri Blass, July 31, 2008.)

58. Page 341, line -1: We never use the type *time* (we use *clock-time*, which needs to be changed to $\langle$*hour*, *minute*, *second*$\rangle$); it should be called *decimal-time*. The function **time-from-moment** has this result type. (Courtesy of Uri Blass, July 30, 2008.)

59. Page 358: The functions **mean-sidereal-year**, **mean-synodic-month**, and **mean-tropical-year** should have type *duration*. Also in the Lisp code (pages 399, 401, and 399, respectively).

60. Page 383, line 13 of `yom-ha-zikkaron`: Change "Friday or Saturday" to "Thursday or Friday":

```
13          ;; If Iyyar 4 is Thursday or Friday, then Wednesday
```

(Courtesy of Enrico Spinielli, June 22, 2008.)