Errata for the book "A First Course in Numerical Methods", by Uri Ascher and Chen Greif

November 28, 2016

In this file we have collected various changes to be made to the first edition of our book. Several have been corrected in the second printing of the book, Fall, 2013. The fresher batch is listed first.

You are welcome to mark these changes in your copy, and to please inform one of us if you find more of these annoying items.

Note: Changes in computer code have also been fixed in the corresponding programs, which are available as a zip file from this book's webpage.

Additional errata for the second printing

1. *p. 47, Fixed Point theorem*: replace 'and $a \le g(x) \le b$ for all $x \in [a, b]$,' by ', $g(a) \ge a$ and $g(b) \le b$,'

2. *p. 83, l. -5*: Replace the entire two-line paragraph starting with 'It can' by 'If the points t_i are chosen so that the columns of A are linearly independent then there is a unique solution to the above matrix problem, and the interpolant $v(t; \mathbf{x})$ is thus uniquely determined.'

3. *p. 113, l. -11 and -10*: replace '$\mathbf{z} = a * \mathbf{x} + \mathbf{y}$' by '$\mathbf{y} \leftarrow a * \mathbf{x} + \mathbf{y}$' in line -11, and replace 'scalar' by 'single-precision' in line -10.

4. *p. 147, l. -6*: replace 'Example 8.1' by 'Example 6.2'

5. *p. 184, l. 16*: replace 'earch' by 'Here the search'

6. *p. 261, l. -16*: replace '27.75' by '13.875' (three times)

7. *p. 279, l. -8* and *p. 281, l. 6*: replace $\frac{1}{m}$ by $\frac{1}{n}$.

8. *p. 288, l. 11*: replace '$\equiv 1$' by '$= \sin(\pi x) \sin(\pi y)$'

9. *p. 323, l. 4*: replace $\frac{f'(8.3)}{2}$ by $\frac{f''(8.3)}{2}$.

10. *p. 323, l. 6 and 8*: replace the divided difference table by

x_i	$f[\cdot]$	$f[\cdot,\cdot]$	$f[\cdot,\cdot,\cdot]$	$f[\cdot,\cdot,\cdot,\cdot]$	$f[\cdot,\cdot,\cdot,\cdot,\cdot]$
8.3	17.564921				
8.3	17.564921	3.116256			
8.3	17.564921	3.116256	0.060241		
8.6	18.505155	3.134113	0.059524	-0.002389	
8.6	18.505155	3.151762	0.058829	-0.002319	0.000233

and the displayed equation that follows by

$$\begin{aligned} p_4(x) &= \sum_{k=0}^{4} f[x_0,\ldots,x_k]\prod_{j=0}^{k-1}(x-x_j) \\ &= 17.564921 + 3.116256(x-8.3) + 0.060241(x-8.3)^2 \\ &\quad - 0.002389(x-8.3)^3 + 0.000233(x-8.3)^3(x-8.6). \end{aligned}$$

11. *p. 393*: in the caption of Figure 13.4 the independent variable should be t rather than x, so apply four corrections to have $p_3(t)$, $p_7(t)$, $p_{15}(t)$ and $p_{31}(t)$.

12. *p. 400, l. 13*: delete the superfluous line

```
yh(1) = .5*(y(1)+y(2)); yh(2) = .5*(y(1)-y(2));
```

13. *p. 403, last line of the DCT algorithm*: delete the superfluous dependence on i: this line should read

$$p_n(x) = \frac{1}{2}a_0 + \sum_{k=1}^{n} a_k \cos(kx).$$

14. *p. 421, footnote*: Add the following:
Note further that $\epsilon \sim \eta|f(x)|$.

15. *p. 422, l. -10*: In the caption of Figure 14.2 replace 'just' by 'proportional to'

16. *p. 422, l. -3*: Relace this formula with

$$E(h_*) = h_*^2 M/6 + \epsilon/h_* = \frac{h_*}{2}\frac{\epsilon}{h_*^2} + \frac{\epsilon}{h_*} = \frac{3\epsilon}{2h_*}.$$

17. *p. 471, l. 6*: the formula should read

$$R_{1,1} = \frac{h}{2}\left[f(a) + f(b) + 2\sum_{k=1}^{r-1} f(a+kh)\right].$$

18. *p. 471, l. 8-10*: Step 2(a) should read as follows:

    set $h = h/2$, and calculate the trapezoidal approximation on the finer mesh by

$$R_{j+1,1} = \frac{1}{2}R_{j,1} + h \sum_{k=1}^{r*2^{j-1}} f(a + (2k-1)h) \ .$$

19. *p. 472, l. 1*: Replace this line by the following:

    For $r = 1$ and $s = 4$ in the Romberg integration algorithm, the obtained values (to 6 digits) are

20. *p. 472, l. 14*: Replace 'for $r = 16$:' by 'for 9 function evaluations:'

21. *p. 487, l. 2*: Replace '$e_i = y(t_i) - e_i$' by '$e_i = y(t_i) - y_i$'

22. *p. 491*: change l. -7 to -5 to read

    [...] But stability decrees that we must look at the test equation $y' = -1000y$. Thus, for Euler's method we need

$$h \leq \frac{1}{500}$$

    for *any* reasonable accuracy after the first few steps!

Errata for the first printing

1. *p. 10, Rolle's Theorem*: replace '$f(a) = f(b) = 0$' by '$f(a) = f(b)$'.

2. *p. 14, last line*: replace '$-\frac{h^2}{3}f'''(x_0)$' by '$-\frac{h^2}{6}f'''(x_0)$'.

3. *p. 30, last line before Example 2.13*: replace 'shifting by L' by 'shifting by U'.

4. *p. 34, l. 11*: replace '$a, b > 0$' by '$a, b > 0;\ a \neq b$'.

5. *p. 46, l. 12 and l. 14*: in item 3 and item 5 of the list, replace 'root' by 'fixed point' .

6. *p. 86, l. -13*: in the equation for A, change entry $(3, 4)$ of the matrix from 1 to -1.

7. *p. 107, l. -8*: in the displayed equation for U, replace $\tilde{P}^{(3)}\tilde{P}^{(2)}\tilde{P}^{(1)}$ by $P^{(3)}P^{(2)}P^{(1)}$.

8. *p. 139, l. -7*: replace '2000' by 'over 100,000'.

9. *p. 159, l. 10*: replace $n \times n$ by $m \times n$.

10. *p. 165, l. 4*: replace $v(t) = x_1 + x_1 t$ by $v(t) = x_1 + x_2 t$.

11. *p. 194, Example 7.12:*

    - l. 6: replace 29 by $\sqrt{29}$.
    - l. 11: replace h_{21} by h_{12}.

12. *p. 207, l. -13*: replace the lines

```
v(3:2:N-2,3:2:N-2) = .25*(v(2:2:N-3,2:2:N-3)+v(2:2:N-3,4:2:N-1)+...
        v(4:2:N-1,4:2:N-1)+v(4:2:N-1,2:2:N-3));
```

    by the lines

```
v(1:2:N,1:2:N) = .25*(vz(1:2:N,1:2:N)+vz(1:2:N,3:2:N+2)+...
        vz(3:2:N+2,3:2:N+2)+vz(3:2:N+2,1:2:N));
```

13. p. 211, l. -2: replace 'any norm you want' by 'the 2-norm'

14. *p. 213, l. 4*: delete this line (i.e., delete Qusetion 9(b)(ii)), and start the next line with 'ii' instead of 'iii'.

15. *p. 214, l. 4*: replace 'Exercise 10' by 'Exercise 5'.

16. *p. 215, l. -12*: In the first equation of Exercise 21, replace u by $\mathbf{x}$, p by $\mathbf{y}$, f by $\mathbf{d}$, and g by $\mathbf{b}$.

17. *p. 217, l. -4*: the equation should read

$$\mu^* = \max\{|\mu_{l,m}| : \ (N+1)/2 \le l \le N, \ 1 \le m \le N\}.$$

18. *p. 231, l. -6*: replace '300' by '320'.

19. *p. 246, lines 3–6*: replace 'Example 8.2' by 'Example 8.4', replace 'the two matrices A and B' by 'the matrix A with shifts $\alpha = 33$ and $\alpha = 35$', and delete Exercise 5.

20. *p. 246, Part (b) of Question 7*: replace current line by

    'What is the largest eigenvalue of $A(\alpha)$?'

21. *p. 246, Part (ii) of Part (d) of Question 7*: replace current 'Show ... iteration.' by

    'Show that if the power method is applied and the initial guess $\mathbf{v}_0$ satisfies $\|\mathbf{v}_0\|_1 = 1$, then in the absence of roundoff errors all subsequent iterates $\mathbf{v}_k$ also have a unit ℓ_1-norm.'

22. *p. 248, caption of Figure 8.9*: replace 'Example 11' by 'Exercise 11'.

23. *p. 262, Table 9.2:*

    Remove negative sign from headings of 4th and 7th columns; they should read $\mathbf{f}_k^T \mathbf{p}_k$.

    Also, the recorded numbers in the columns of $\phi_k - \phi(\mathbf{x}^*)$ and $\mathbf{f}_k^T \mathbf{p}_k$ should be half their currently displayed value. The correct table should read

k	$\|\mathbf{x}_k - \mathbf{x}^*\|$	$\phi_k - \phi(\mathbf{x}^*)$	$\mathbf{f}_k^T \mathbf{p}_k$	$\|\mathbf{x}_k - \mathbf{x}^*\|$	$\phi_k - \phi(\mathbf{x}^*)$	$\mathbf{f}_k^T \mathbf{p}_k$
0	5.01e+00	4.09e+01	−7.27e+01	5.01e+00	1.02e+00	−1.65e+00
1	8.66e-01	1.21e+00	−2.26e+00	3.96e+00	1.28e-01	−2.94e-02
2	6.49e-02	1.20e-02	−2.32e-02	4.22e+00	1.16e-01	−3.21e-01
3	1.39e-01	1.72e-03	−3.16e-03	1.66e+01	2.87e+02	−4.65e+02
4	2.10e-02	6.91e-05	−1.35e-04	6.14e+00	2.61e+01	−3.16e+01
5	1.38e-03	1.43e-07	−2.86e-07	3.43e+00	7.98e+00	−1.85e+00
6	3.03e-06	1.09e-12	−2.19e-12	2.97e+00	7.10e+00	−4.22e-03
7	2.84e-11	6.16e-23	−1.23e-22	3.04e+00	7.10e+00	−2.84e-08
8				3.04e+00	7.10e+00	−5.42e-19

24. *p. 264, line 21:* right after the formula for α_k, insert the sentence: 'Note that this may work only if $\psi'(0) < 0$.'

25. *p. 264, 6th line of the Matlab script:* replace the condition

    ```
    if mu < .1
    ```

    by

    ```
    if mu < .1 || pgphi >= 0
    ```

26. *p. 265, Example 9.6:*
    - *lines 3, 5 and 8:* change $\mathbf{x}_0 = (0, 0)^T$ to $\mathbf{x}_0 = (0, 0.3)^T$ (three occurrences in total).
    - *l. 9:* change '5 iterations' to '6 iterations'.
    - *l. 10:* replace 'The first step length ... this first step,' by: 'The first three step lengths are less than 0.5 each, whereas in the last three,'

27. *p. 288, l. -4*: replace the right hand side of the formula by

$$\ln(1 + ih)$$

28. *p. 292, last line of exercise 18*: replace $\gamma = 10^{-1}$ by $\gamma = 10^{-3}$.

29. *p. 292, first line of Exercise 20*: replace 'force' by 'forced'.

30. *p. 405, first line of Exercise 5*: replace '387' by '388'.

31. *p. 419, Table 14.2:* remove the last sentence in the caption and replace the value 0 in the column headed e_g by 1.46e-11.

32. *p. 421, footnote:* replace $\eta = 2^{-52} \approx 2.2 \times 10^{-16}$ by $\eta = 2^{-53} \approx 1.1 \times 10^{-16}$.

33. *p. 438, l. 5 (1st line of Exercise 14.15(a))*: replace $h = n/\pi$ by $h = \pi/n$.

34. *p. 456, l. -10, and p. 457, l. 9, and p. 459, l. 3*: the denominator in the rightmost expression in all these formulas is missing an exclamation mark. It should read
$$(2n+3)!((2n+2)!)^2$$

35. *p. 505, Table 16.6:* last value in column '(2,2) error' should be 7.2e-8.

36. *p. 532, l. 7* replace 'the same' by 'a similar'