of the input variables. By contrast, a script M-file has no input variables; when a script is invoked it uses the variables that are already in existence in the current MATLAB session. A MATLAB function M-file should be saved under the same file name as the function name, so when we created the function triple, we saved it as triple.m.

A.11 EXERCISES

Write a MATLAB function M-file that calculates the vector triple product $\mathbf{u} \times \mathbf{v} \times \mathbf{w}$. Test your function using the vectors $\mathbf{a} = [1, 1, 2]$, $\mathbf{b} = [2, -2, 1]$, and $\mathbf{c} = [0, 1, 4]$.

2. Use the script lsplot to choose an integer n so that the best least-squares polynomial approximation of degree n or less looks reasonable for the data $(x_i, y_i) = (i, \ln i)$, $i = 1, 2, \ldots, 10$. Restrict n to be between 1 and 5.

ANSWERS TO SELECTED ODD-NUMBERED EXERCISES*

CHAPTER 1

Exercises 1.1, p. 12

1. Linear

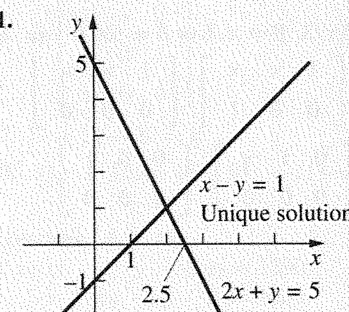
3. Linear

5. Nonlinear

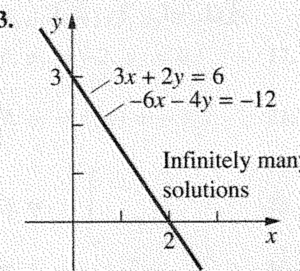
7. $\begin{aligned} x_1 + 3x_2 &= 7 \\ 4x_1 - x_2 &= 2 \end{aligned}$

9. $\begin{aligned} x_1 + x_2 &= 0 \\ 3x_1 + 4x_2 &= -1 \\ -x_1 + 2x_2 &= -3 \end{aligned}$

11.



13.



17. $\begin{aligned} x_1 &= -3t + 4 \\ x_2 &= 2t - 1 \\ x_3 &= t \end{aligned}$

19. $A = \begin{bmatrix} 2 & 1 & 6 \\ 4 & 3 & 8 \end{bmatrix}$

21. $Q = \begin{bmatrix} 1 & 4 & -3 \\ 2 & 1 & 1 \\ 3 & 2 & 1 \end{bmatrix}$

23. $\begin{aligned} 2x_1 + x_2 &= 6 \\ 4x_1 + 3x_2 &= 8 \end{aligned}$ and $\begin{aligned} x_1 + 4x_2 &= -3 \\ 2x_1 + x_2 &= 1 \\ 3x_1 + 2x_2 &= 1 \end{aligned}$

*Many of the problems have answers that contain parameters or answers that can be written in a variety of forms. For problems of this sort, we have presented one possible form of the answer. Your solution may have a different form and still be correct. You can frequently check

5. $A = \begin{bmatrix} 1 & 1 & -1 \\ 2 & 0 & -1 \end{bmatrix}$, $B = \begin{bmatrix} 1 & 1 & -1 & 2 \\ 2 & 0 & -1 & 1 \end{bmatrix}$

7. $A = \begin{bmatrix} 1 & 1 & 2 \\ 3 & 4 & -1 \\ -1 & 1 & 1 \end{bmatrix}$,

$B = \begin{bmatrix} 1 & 1 & 2 & 6 \\ 3 & 4 & -1 & 5 \\ -1 & 1 & 1 & 2 \end{bmatrix}$

$A = \begin{bmatrix} 1 & 1 & 1 \\ 2 & 3 & 1 \\ 1 & -1 & 3 \end{bmatrix}$, $B = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 3 & 1 & 2 \\ 1 & -1 & 3 & 2 \end{bmatrix}$

$$\begin{aligned} x_1 + 2x_2 - x_3 &= 1 \\ -x_2 + 3x_3 &= 1 \\ 5x_2 - 2x_3 &= 6 \end{aligned}$$

$$\begin{aligned} x_1 + x_2 &= 9 \\ -2x_2 &= -2 \\ -2x_2 &= -21 \end{aligned}$$

$$\begin{aligned} x_1 + 2x_2 - x_3 + x_4 &= 1 \\ x_2 + x_3 - x_4 &= 3 \\ 3x_2 + 6x_3 &= 1 \end{aligned}$$

Exercises 1.2, p. 26

a) The matrix is in echelon form.

b) The operation $R_1 - 2R_2$ yields reduced echelon form $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$.

a) The operations $R_2 - 2R_1$, $(1/2)R_1$, $R_2 - 4R_1$, $(1/5)R_2$ yield echelon form

$$\begin{bmatrix} 1 & 3/2 & 1/2 \\ 0 & 1 & 2/5 \end{bmatrix}.$$

a) The operations $R_1 \leftrightarrow R_2$, $(1/2)R_1$, $(1/2)R_2$ yield echelon form

$$\begin{bmatrix} 1 & 0 & 1/2 & 2 \\ 0 & 0 & 1 & 3/2 \end{bmatrix}.$$

a) The matrix is in echelon form.

b) The operations $R_1 - 2R_3$, $R_2 - 4R_3$, $R_1 - 3R_2$ yield reduced echelon form

$$\begin{bmatrix} 1 & 0 & 0 & 5 \\ 0 & 1 & 0 & 2 \end{bmatrix}$$

9. a) The operation $(1/2)R_2$ yields echelon form

$$\begin{bmatrix} 1 & 2 & -1 & -2 \\ 0 & 1 & -1 & -3/2 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

11. $x_1 = 0$, $x_2 = 0$

13. $x_1 = -2 + 5x_3$, $x_2 = 1 - 3x_3$, x_3 arbitrary

15. The system is inconsistent.

17. $x_1 = x_3 = x_4 = 0$; x_2 arbitrary

19. The system is inconsistent.

21. $x_1 = -1 - (1/2)x_2 + (1/2)x_4$, $x_3 = 1 - x_4$, x_2 and x_4 arbitrary, $x_5 = 0$

23. Inconsistent

25. $x_1 = 2 - x_2$, x_2 arbitrary

27. $x_1 = 2 - x_2 + x_3$, x_2 and x_3 arbitrary

29. $x_1 = 3 - 2x_3$, $x_2 = -2 + 3x_3$, x_3 arbitrary

31. $x_1 = 3 - (7x_4 - 16x_5)/2$, $x_2 = (x_4 + 2x_5)/2$, $x_3 = -2 + (5x_4 - 12x_5)/2$, x_4 and x_5 arbitrary

33. Inconsistent

35. Inconsistent

37. All values of a except $a = 8$

39. $a = 3$ or $a = -3$

41. $\alpha = \pi/3$ or $\alpha = 5\pi/3$; $\beta = \pi/6$ or $\beta = 5\pi/6$

45. $\begin{bmatrix} 1 & \times & \times \\ 0 & 1 & \times \end{bmatrix}$, $\begin{bmatrix} 1 & \times & \times \\ 0 & 0 & 1 \end{bmatrix}$, $\begin{bmatrix} 1 & \times & \times \\ 0 & 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 1 & \times \\ 0 & 0 & 1 \end{bmatrix}$, $\begin{bmatrix} 0 & 1 & \times \\ 0 & 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$, $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

47. The operations $R_2 - 2R_1$, $R_1 + 2R_2$, $-R_2$ transform B to I. The operations $R_2 - 3R_1$, $R_1 + R_2$, $(-1/2)R_2$ reduce C to I, so the operations $-2R_2$, $R_1 - R_2$, $R_2 + 3R_1$ transform I to C. Thus the operations $R_2 - 2R_1$, $R_1 + 2R_2$, $-R_2$, $-2R_2$, $R_1 - R_2$, $R_2 + 3R_1$ transform B to C.

49. $N = 135$

51. The amounts were \$39, \$21, and \$12.

53. Let A denote the number of adults, S the number of students, and C the number of children. Possible solutions are: $A = 5k$, $S = 67 - 11k$, $C = 12 + 6k$, where $k = 0, 1, \ldots, 6$.

55. $n(n+1)/2$

Exercises 1.3, p. 37

1. $\begin{bmatrix} 1 & 1 & 0 & 5/6 \\ 0 & 0 & 1 & 2/3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ $n = 3$, $r = 2$, x_2

3. $\begin{bmatrix} 1 & 0 & 4 & 0 & 13/2 \\ 0 & 1 & -1 & 0 & -3/2 \\ 0 & 0 & 0 & 1 & 1/2 \end{bmatrix}$ $n = 4$, $r = 3$, x_3

5. $r = 2$, $r = 1$, $r = 0$

7. Infinitely many solutions

9. Infinitely many solutions, a unique solution, or no solution

11. A unique solution or infinitely many solutions

13. Infinitely many solutions

15. A unique solution or infinitely many solutions

17. Infinitely many solutions

19. There are nontrivial solutions.

21. There is only the trivial solution.

23. $a = 1$

25. a) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$

27. $7x + 2y - 30 = 0$

29. $-3x^2 + 3xy + y^2 - 54y + 113 = 0$

Exercises 1.4, p. 44

1. a)
$$\begin{aligned} x_1 \qquad\qquad + x_4 &= 1200 \\ x_1 + x_2 \qquad\qquad &= 1000 \\ x_3 + x_4 &= 600 \\ x_2 + x_3 \qquad &= 400 \end{aligned}$$

b) $x_1 = 1100$, $x_2 = -100$, $x_3 = 500$;

c) The minimum value is $x_1 = 600$ and the maximum value is $x_1 = 1000$.

3. $x_2 = 800$, $x_3 = 400$, $x_4 = 200$

5. $I_1 = 0.05$, $I_2 = 0.6$, $I_3 = 0.55$

7. $I_1 = 35/13$, $I_2 = 20/13$, $I_3 = 15/13$

Exercises 1.5, p. 58

1. a) $\begin{bmatrix} 2 & 0 \\ \ldots \end{bmatrix}$; **b)** $\begin{bmatrix} 0 & 4 \\ \ldots \end{bmatrix}$;

c) $\begin{bmatrix} 0 & -6 \\ 6 & 18 \end{bmatrix}$; **d)** $\begin{bmatrix} -6 & 8 \\ 4 & 6 \end{bmatrix}$

3. $\begin{bmatrix} -2 & -2 \\ 0 & 0 \end{bmatrix}$ **5.** $\begin{bmatrix} -1 & -1 \\ 0 & 0 \end{bmatrix}$

7. a) $\begin{bmatrix} 3 \\ -3 \end{bmatrix}$; **b)** $\begin{bmatrix} 3 \\ 4 \end{bmatrix}$; **c)** $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$

9. a) $\begin{bmatrix} 2 \\ 1 \end{bmatrix}$; **b)** $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$; **c)** $\begin{bmatrix} 17 \\ 14 \end{bmatrix}$

11. a) $\begin{bmatrix} 2 \\ 3 \end{bmatrix}$; **b)** $\begin{bmatrix} 20 \\ 16 \end{bmatrix}$

13. $a_1 = 11/3$, $a_2 = -4/3$

15. $a_1 = -2$, $a_2 = 0$ **17.** No solution

19. $a_1 = 4$, $a_2 = -3/2$ **21.** $\mathbf{w}_2 = \begin{bmatrix} 1 \\ 3 \end{bmatrix}$

23. $\mathbf{w}_3 = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$ **25.** $\begin{bmatrix} -4 & 6 \\ 2 & 12 \end{bmatrix}$

27. $\begin{bmatrix} 4 & 12 \\ 4 & 10 \end{bmatrix}$ **29.** $\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

31. $AB = \begin{bmatrix} 5 & 16 \\ 5 & 18 \end{bmatrix}$, $BA = \begin{bmatrix} 4 & 11 \\ 6 & 19 \end{bmatrix}$

33. $A\mathbf{u} = \begin{bmatrix} 11 \\ 13 \end{bmatrix}$, $\mathbf{v}A = [8, 22]$

35. 66 **37.** $\begin{bmatrix} 5 & 10 \\ 8 & 12 \\ 15 & 20 \\ 8 & 17 \end{bmatrix}$ **39.** $\begin{bmatrix} 27 \\ 28 \\ 43 \\ 47 \end{bmatrix}$

41. $(BA)\mathbf{u} = B(A\mathbf{u}) = \begin{bmatrix} 37 \\ 63 \end{bmatrix}$

43. $\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -2 \\ 3 \\ 0 \end{bmatrix} + x_3 \begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix}$

45. $\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ \ldots \end{bmatrix} = x_3 \begin{bmatrix} 1 \\ -2 \\ 1 \\ 0 \\ \ldots \end{bmatrix} + x_5 \begin{bmatrix} 1 \\ -1 \\ 0 \\ -1 \\ \ldots \end{bmatrix}$