INSTRUCTOR'S SOLUTIONS MANUAL

PROBABILITY AND STATISTICAL INFERENCE

NINTH EDITION

GLOBAL EDITION

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Preface

This solutions manual provides answers for the even-numbered exercises in *Probability and Statistical Inference*, 9th edition, Global edition, by Robert V. Hogg, Elliot A. Tanis, and Dale L. Zimmerman. Complete solutions are given for most of these exercises. You, the instructor, may decide how many of these solutions and answers you want to make available to your students. Note that the answers for the odd-numbered exercises are given in the textbook.

All of the figures in this manual were generated using *Maple*, a computer algebra system. Most of the figures were generated and many of the solutions, especially those involving data, were solved using procedures that were written by Zaven Karian from Denison University. We thank him for providing these. These procedures are available free of charge for your use. They are available for down load at http://www.math.hope.edu/tanis/. Short descriptions of these procedures are provided on the "Maple Card." Complete descriptions of these procedures are given in *Probability and Statistics: Explorations with MAPLE*, second edition, 1999, written by Zaven Karian and Elliot Tanis, published by Prentice Hall (ISBN 0-13-021536-8). You can download a copy of this manual at http://www.math.hope.edu/tanis/MapleManual.pdf.

Our hope is that this solutions manual will be helpful to each of you in your teaching.

If you find an error or wish to make a suggestion, send these to Elliot Tanis, `tanis@hope.edu`, and he will post corrections on his web page, http://www.math.hope.edu/tanis/.

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Chapter 1

Probability

1.1 Properties of Probability

1.1-2 Probability of insuring exactly 1 car, $P(A) = 0.1$
Probability of insuring more than 1 car, $P(B) = 0.9$
Probability of insuring a sports car, $P(C) = 0.25$

$P(B \cap C) = 0.15$

$P(A \cap C) = P(C) - P(B \cap C) = 0.1 = P(A)$

$P(A \cap C') = 0.$

1.1-4 **(a)** $S = \{$HHHHH, HHHHT, HHHTH, HHTHH, HTHHH, THHHH, TTHHH, THTHH, THHTH, THHHT, HTTHH, HTHTH, HTHHT, HHTTH, HHTHT, HHHTT, HHTTT, HTHTT, HTTHT, HTTTH, THHTT, THTHT, THTTH, TTHHT, TTHTH, TTTHH, TTTTH, TTTHT, TTHTT, THTTT, HTTTT, TTTTT$\}$

(b) **(i)** 6/32, **(ii)** 0, **(iii)** 26/32, **(iv)** 5/32, **(v)** 5/32, **(vi)** 17/32, **(vii)** 5/32.

1.1-6 **(a)** $P(A \cup B) = 0.4 + 0.5 - 0.3 = 0.6;$

(b)
$$\begin{aligned} A &= (A \cap B') \cup (A \cap B) \\ P(A) &= P(A \cap B') + P(A \cap B) \\ 0.4 &= P(A \cap B') + 0.3 \\ P(A \cap B') &= 0.1; \end{aligned}$$

(c) $P(A' \cup B') = P[(A \cap B)'] = 1 - P(A \cap B) = 1 - 0.3 = 0.7.$

1.1-8 Let $A = \{$lab work done$\}$, $B = \{$referral to a specialist$\}$,

$P(A) = 0.41$, $P(B) = 0.53$, $P([A \cup B]') = 0.21$.

$$\begin{aligned} P(A \cup B) &= P(A) + P(B) - P(A \cap B) \\ 0.79 &= 0.41 + 0.53 - P(A \cap B) \\ P(A \cap B) &= 0.41 + 0.53 - 0.79 \;=\; 0.15. \end{aligned}$$

1.1-10
$$\begin{aligned} A \cup B \cup C &= A \cup (B \cup C) \\ P(A \cup B \cup C) &= P(A) + P(B \cup C) - P[A \cap (B \cup C)] \\ &= P(A) + P(B) + P(C) - P(B \cap C) - P[(A \cap B) \cup (A \cap C)] \\ &= P(A) + P(B) + P(C) - P(B \cap C) - P(A \cap B) - P(A \cap C) \\ &\quad + P(A \cap B \cap C). \end{aligned}$$

1.1-12 **(a)** 5/12; **(b)** 7/12; **(c)** 0; **(d)** 5/6.

1.1-14 $P(A) = \dfrac{2[r - r(\sqrt{3}/2)]}{2r} = 1 - \dfrac{\sqrt{3}}{2}.$

1.1-16 Note that the respective probabilities are $p_0,\ p_1 = p_0/4,\ p_2 = p_0/4^2, \cdots$.

$$\begin{aligned}\sum_{k=0}^{\infty}\frac{p_0}{4^k} &= 1\\ \frac{p_0}{1-1/4} &= 1\\ p_0 &= \frac{3}{4}\end{aligned}$$

$$1 - p_0 - p_1 = 1 - \frac{15}{16} = \frac{1}{16}.$$

1.2 Methods of Enumeration

1.2-2 **(a)** Number of experiements = $(5 \times 8 \times 4) = 160$.
(b) Number of experiments with each factor at 4 levels = $(4) \times (4) \times (4) = 64$.

1.2-4 **(a)** $4\binom{6}{3} = 80$;

(b) $4(2^6) = 256$;

(c) $\dfrac{(4-1+3)!}{(4-1)!3!} = 20$.

1.2-6 $S =$ { DDD, DDFD, DFDD, FDDD, DDFFD, DFDFD, FDDFD, DFFDD, FDFDD, FFDDD, FFF, FFDF, FDFF, DFFF FFDDF, FDFDF, DFFDF, FDDFF, DFDFF, DDFFF } so there are 20 possibilities.

1.2-8 Total number of varieties of pizzas = $4 \times 3 \times (2)^{16} = 786432$.

1.2-10
$$\begin{aligned}\binom{n-1}{r} + \binom{n-1}{r-1} &= \frac{(n-1)!}{r!(n-1-r)!} + \frac{(n-1)!}{(r-1)!(n-r)!}\\ &= \frac{(n-r)(n-1)! + r(n-1)!}{r!(n-r)!} = \frac{n!}{r!(n-r)!} = \binom{n}{r}.\end{aligned}$$

1.2-12
$$\begin{aligned}0 &= (1-1)^n = \sum_{r=0}^{n}\binom{n}{r}(-1)^r(1)^{n-r} = \sum_{r=0}^{n}(-1)^r\binom{n}{r}.\\ 2^n &= (1+1)^n = \sum_{r=0}^{n}\binom{n}{r}(1)^r(1)^{n-r} = \sum_{r=0}^{n}\binom{n}{r}.\end{aligned}$$

1.2-14 $\dbinom{10-1+36}{36} = \dfrac{45!}{36!9!} = 886{,}163{,}135.$

1.2-16 **(a)** $\dfrac{\binom{19}{3}\binom{52-19}{6}}{\binom{52}{9}} = \dfrac{102{,}486}{351{,}325} = 0.2917;$

(b) $\dfrac{\binom{19}{3}\binom{10}{2}\binom{7}{1}\binom{3}{0}\binom{5}{1}\binom{2}{0}\binom{6}{2}}{\binom{52}{9}} = \dfrac{7{,}695}{1{,}236{,}664} = 0.00622.$

1.3 Conditional Probability

1.3-2 **(a)** $\dfrac{1041}{1456}$;

(b) $\dfrac{392}{633}$;

(c) $\dfrac{649}{823}$.

(d) The proportion of women who favor a gun law is greater than the proportion of men who favor a gun law.

1.3-4 **(a)** Probability of drawing 3 spades $= \dfrac{13}{52}\cdot\dfrac{12}{51}\cdot\dfrac{11}{50} = \dfrac{33}{2550}$.

(b) Probability of drawing a spade on the first draw, a heart on the second draw, and a diamond on the third draw $= \dfrac{13}{52}\cdot\dfrac{13}{51}\cdot\dfrac{13}{50} = \dfrac{169}{10200}$.

(c) Probability of drawing a spade on the first draw, a heart on the second draw, and an ace on the third draw

$$= \frac{13}{52}\cdot\frac{13}{51}\cdot\frac{4}{50} + \left(\frac{13}{52}\cdot\frac{13}{51}\cdot\frac{3}{50}\right)\times 2 + \frac{13}{52}\cdot\frac{13}{51}\cdot\frac{2}{50} = \frac{52}{10200} + \frac{78}{10200} + \frac{26}{10200} = \frac{156}{10200}.$$

1.3-6 Let H ={died from heart disease}; P ={at least one parent had heart disease}.

$$P(H \mid P') = \frac{N(H \cap P')}{N(P')} = \frac{110}{648}.$$

1.3-8 **(a)** $\dfrac{3}{20}\cdot\dfrac{2}{19}\cdot\dfrac{1}{18} = \dfrac{1}{1140}$;

(b) $\dfrac{\dbinom{3}{2}\dbinom{17}{1}}{\dbinom{20}{3}}\cdot\dfrac{1}{17} = \dfrac{1}{380}$;

(c) $\displaystyle\sum_{k=1}^{9} \frac{\dbinom{3}{2}\dbinom{17}{2k-2}}{\dbinom{20}{2k}}\cdot\frac{1}{20-2k} = \frac{35}{76} = 0.4605.$

(d) Draw second. The probability of winning is $1 - 0.4605 = 0.5395$.

1.3-10 **(a)** $P(A) = \dfrac{52}{52}\cdot\dfrac{51}{52}\cdot\dfrac{50}{52}\cdot\dfrac{49}{52}\cdot\dfrac{48}{52}\cdot\dfrac{47}{52} = \dfrac{8{,}808{,}975}{11{,}881{,}376} = 0.74141$;

(b) $P(A') = 1 - P(A) = 0.25859$.

1.3-12 **(a)** It doesn't matter because $P(B_1) = P(B_5) = P(B_{10}) = P(B_{20}) = P(B_{30}) = \dfrac{2}{30} = \dfrac{1}{15}$.

(b) $P(B) = \dfrac{4}{30} = \dfrac{2}{15}$ on each draw.

1.3-14 **(a)** $P(A_1) = 30/100$;

(b) $P(A_3 \cap B_2) = 9/100$;

(c) $P(A_2 \cup B_3) = 41/100 + 28/100 - 9/100 = 60/100$;

(d) $P(A_1 \mid B_2) = 11/41$;

(e) $P(B_1 \mid A_3) = 13/29$.

1.3-16 Probability that an employee has a college degree and works in sales = 0.6 × 0.1 = 0.06.
Probability that an employee does not have a college degree and works in sales
= 0.8 × (1 − 0.6) = 0.32.

Probability that an employee chosen at random works in sales = 0.32 + 0.06 = 0.38.

1.4 Independent Events

1.4-2 **(a)**
$$\begin{aligned} P(A \cap B) &= P(A)P(B) = (0.3)(0.6) = 0.18; \\ P(A \cup B) &= P(A) + P(B) - P(A \cap B) \\ &= 0.3 + 0.6 - 0.18 \\ &= 0.72. \end{aligned}$$

(b) $P(A|B) = \dfrac{P(A \cap B)}{P(B)} = \dfrac{0}{0.6} = 0.$

1.4-4 Proof of **(b)**:
$$\begin{aligned} P(A' \cap B) &= P(B)P(A'|B) \\ &= P(B)[1 - P(A|B)] \\ &= P(B)[1 - P(A)] \\ &= P(B)P(A'). \end{aligned}$$

Proof of **(c)**:
$$\begin{aligned} P(A' \cap B') &= P[(A \cup B)'] \\ &= 1 - P(A \cup B) \\ &= 1 - P(A) - P(B) + P(A \cap B) \\ &= 1 - P(A) - P(B) + P(A)P(B) \\ &= [1 - P(A)][1 - P(B)] \\ &= P(A')P(B'). \end{aligned}$$

1.4-6
$$\begin{aligned} P[A \cap (B \cap C)] &= P[A \cap B \cap C] \\ &= P(A)P(B)P(C) \\ &= P(A)P(B \cap C). \end{aligned}$$

$$\begin{aligned} P[A \cap (B \cup C)] &= P[(A \cap B) \cup (A \cap C)] \\ &= P(A \cap B) + P(A \cap C) - P(A \cap B \cap C) \\ &= P(A)P(B) + P(A)P(C) - P(A)P(B)P(C) \\ &= P(A)[P(B) + P(C) - P(B \cap C)] \\ &= P(A)P(B \cup C). \end{aligned}$$

$$\begin{aligned} P[A' \cap (B \cap C')] &= P(A' \cap C' \cap B) \\ &= P(B)[P(A' \cap C') \mid B] \\ &= P(B)[1 - P(A \cup C \mid B)] \\ &= P(B)[1 - P(A \cup C)] \\ &= P(B)P[(A \cup C)'] \\ &= P(B)P(A' \cap C') \\ &= P(B)P(A')P(C') \\ &= P(A')P(B)P(C') \\ &= P(A')P(B \cap C') \end{aligned}$$

$$\begin{aligned} P[A' \cap B' \cap C'] &= P[(A \cup B \cup C)'] \\ &= 1 - P(A \cup B \cup C) \\ &= 1 - P(A) - P(B) - P(C) + P(A)P(B) + P(A)P(C) + \\ &\qquad P(B)P(C) - PA)P(B)P(C) \\ &= [1 - P(A)][1 - P(B)][1 - P(C)] \\ &= P(A')P(B')P(C'). \end{aligned}$$

1.4-8 Probability that exactly 2 of the 3 dice came up orange

$$= \frac{2}{6}\cdot\frac{3}{6}\cdot\frac{2}{6}+\frac{4}{6}\cdot\frac{3}{6}\cdot\frac{4}{6}+\frac{2}{6}\cdot\frac{3}{6}\cdot\frac{4}{6}=\frac{1}{18}+\frac{4}{18}+\frac{2}{18}=\frac{7}{18}.$$

1.4-10 **(a)** $\frac{3}{4}\cdot\frac{3}{4}=\frac{9}{16}$;

(b) $\frac{1}{4}\cdot\frac{3}{4}+\frac{3}{4}\cdot\frac{2}{4}=\frac{9}{16}$;

(c) $\frac{2}{4}\cdot\frac{1}{4}+\frac{2}{4}\cdot\frac{4}{4}=\frac{10}{16}$.

1.4-12 **(a)** $\frac{1}{28}$

(b) $\frac{1}{28}$

(c) $\frac{1}{28}$

(d) $\frac{8!}{4!4!}\cdot\frac{1}{2^8}$

1.4-14 **(a)** $1-(0.4)^3=1-0.064=0.936$;

(b) $1-(0.4)^8=1-0.00065536=0.99934464$.

1.4-16 **(a)** $\sum_{k=0}^{\infty}\frac{1}{5}\left(\frac{4}{5}\right)^{2k}=\frac{5}{9}$;

(b) $\frac{1}{5}+\frac{4}{5}\cdot\frac{3}{4}\cdot\frac{1}{3}+\frac{4}{5}\cdot\frac{3}{4}\cdot\frac{2}{3}\cdot\frac{1}{2}\cdot\frac{1}{1}=\frac{3}{5}$.

1.4-18 **(a)** 7; **(b)** $(1/2)^7$; **(c)** 63; **(d)** No! $(1/2)^{63}=1/9{,}223{,}372{,}036{,}854{,}775{,}808$.

1.4-20 No.

1.5 Bayes' Theorem

1.5-2 **(a)** $P(G)=P(A)\cdot P(G\mid A)+P(B)\cdot P(G\mid B)$

$$= 0.95\times 0.3+0.7\times 0.7=0.775$$

(b) $P(A\mid G)=\frac{P(A\cap G)}{P(G)}=\frac{P(G\mid A)\cdot P(A)}{P(G)}=\frac{0.285}{0.775}=0.37$

1.5-4 Let event B denote an accident and let A_1 be the event that age of the driver is 16–25. Then

$$\begin{aligned} P(A_1\mid B) &= \frac{(0.1)(0.05)}{(0.1)(0.05)+(0.55)(0.02)+(0.20)(0.03)+(0.15)(0.04)} \\ &= \frac{50}{50+110+60+60}=\frac{50}{280}=0.179. \end{aligned}$$

1.5-6 Let B be the event that the policyholder dies. Let A_1, A_2, A_3 be the events that the deceased is standard, preferred and ultra-preferred, respectively. Then

$$\begin{aligned} P(A_1 \mid B) &= \frac{(0.60)(0.01)}{(0.60)(0.01) + (0.30)(0.008) + (0.10)(0.007)} \\ &= \frac{60}{60+24+7} = \frac{60}{91} = 0.659; \\ P(A_2 \mid B) &= \frac{24}{91} = 0.264; \\ P(A_3 \mid B) &= \frac{7}{91} = 0.077. \end{aligned}$$

1.5-8 Let A be the event that the tablet is under warranty.

$$\begin{aligned} P(B_1 \mid A) &= \frac{(0.40)(0.10)}{(0.40)(0.10) + (0.30)(0.05) + (0.20)(0.03) + (0.10)(0.02)} \\ &= \frac{40}{40+15+6+2} = \frac{40}{63} = 0.635; \\ P(B_2 \mid A) &= \frac{15}{63} = 0.238; \\ P(B_3 \mid A) &= \frac{6}{63} = 0.095; \\ P(B_4 \mid A) &= \frac{2}{63} = 0.032. \end{aligned}$$

1.5-10 **(a)** $P(D^+) = (0.02)(0.92) + (0.98)(0.05) = 0.0184 + 0.0490 = 0.0674;$

(b) $P(A^- \mid D^+) = \dfrac{0.0490}{0.0674} = 0.727;\ P(A^+ \mid D^+) = \dfrac{0.0184}{0.0674} = 0.273;$

(c) $P(A^- \mid D^-) = \dfrac{(0.98)(0.95)}{(0.02)(0.08) + (0.98)(0.95)} = \dfrac{9310}{16 + 9310} = 0.998;$

$P(A^+ \mid D^-) = 0.002.$

(d) Yes, particularly those in part (b).

1.5-12 Let $D = \{\text{has the disease}\}$, $DP = \{\text{detects presence of disease}\}$. Then

$$\begin{aligned} P(D \mid DP) &= \frac{P(D \cap DP)}{P(DP)} \\ &= \frac{P(D) \cdot P(DP \mid D)}{P(D) \cdot P(DP \mid D) + P(D') \cdot P(DP \mid D')} \\ &= \frac{(0.005)(0.90)}{(0.005)(0.90) + (0.995)(0.02)} \\ &= \frac{0.0045}{0.0045 + 0.199} = \frac{0.0045}{0.0244} = 0.1844. \end{aligned}$$

1.5-14 Let $D = \{\text{defective roll}\}$. Then

$$P(I \mid D) = \frac{P(I \cap D)}{P(D)} = \frac{P(D \mid I) \cdot P(I)}{P(D \mid I) \cdot P(I) + P(D \mid II) \cdot P(II)}$$

$$= \frac{0.04 \times 0.55}{(0.04 \times 0.55) + (0.07 \times 0.45)} = \frac{0.022}{0.0535} = 0.41$$

Chapter 2

Discrete Distributions

2.1 Random Variables of the Discrete Type

2.1-2 **(a)**

$$f(x) = \begin{cases} 8/13, & x = 1, \\ 4/13, & x = 4, \\ 1/13, & x = 8, \end{cases}$$

(b)

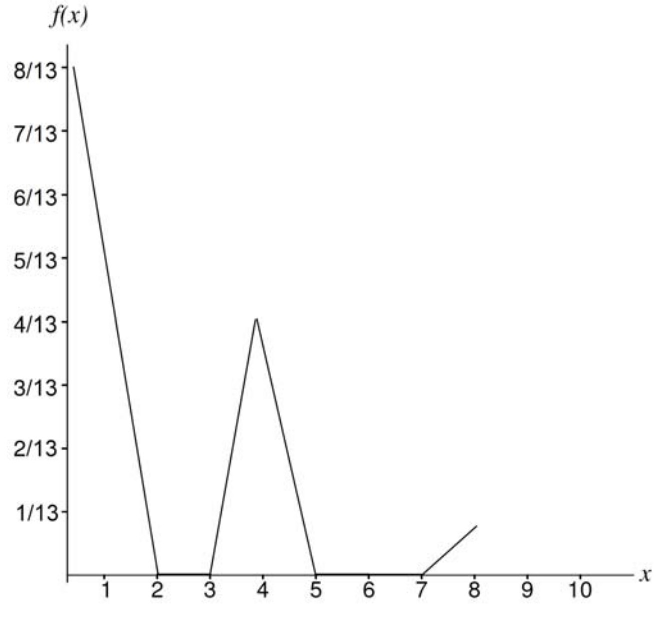

Figure 2.1–2: Line graph.

2.1-4 **(a)** $f(x) = \dfrac{1}{10}, \qquad x = 0, 1, 2, \cdots, 9;$

(b) $\mathcal{N}(\{0\})/150 = 11/150 = 0.073;\quad \mathcal{N}(\{5\})/150 = 13/150 = 0.087;$
$\mathcal{N}(\{1\})/150 = 14/150 = 0.093;\quad \mathcal{N}(\{6\})/150 = 22/150 = 0.147;$
$\mathcal{N}(\{2\})/150 = 13/150 = 0.087;\quad \mathcal{N}(\{7\})/150 = 16/150 = 0.107;$
$\mathcal{N}(\{3\})/150 = 12/150 = 0.080;\quad \mathcal{N}(\{8\})/150 = 18/150 = 0.120;$
$\mathcal{N}(\{4\})/150 = 16/150 = 0.107;\quad \mathcal{N}(\{9\})/150 = 15/150 = 0.100.$

(c)

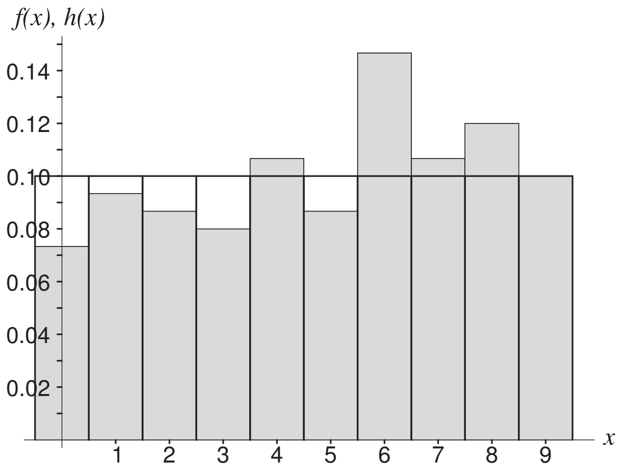

Figure 2.1–4: Michigan daily lottery digits

2.1-6 **(a)** $f(x) = \dfrac{6 - |\,7 - x\,|}{36}$, $x = 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.$

(b)

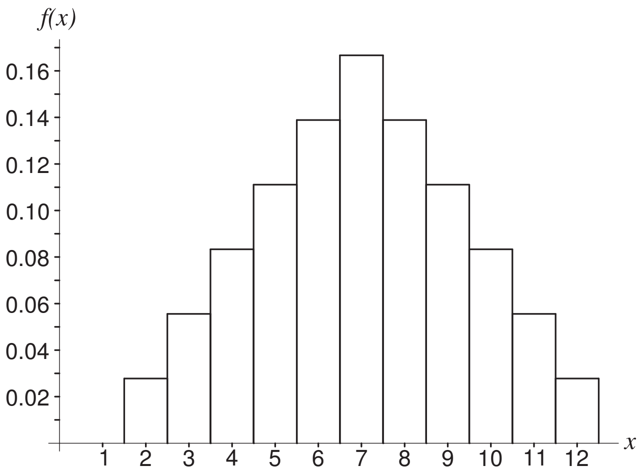

Figure 2.1–6: Probability histogram for the sum of a pair of dice

2.1-8 **(a)** The space of W is $S = \{1, 3, 5, 7, 9, 11, 13\}$.

$$f(w) = \begin{cases} 1/12, & w = 1 \\ 1/6, & w = 3 \\ 1/6, & w = 5 \\ 1/6, & w = 7 \\ 1/6, & w = 9 \\ 1/6, & w = 11 \\ 1/12, & w = 13 \end{cases}$$

(b)

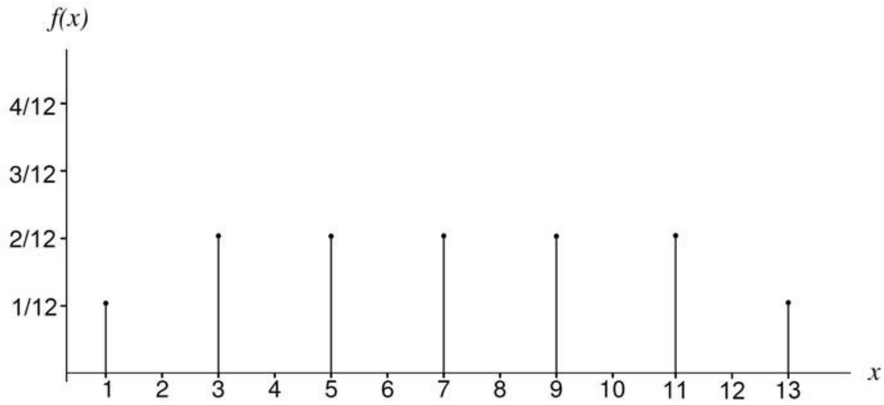

Figure 2.1–8: Probability histogram of sum of two special dice

2.1-10 **(a)** Probability of the sample containing exactly one defective item

$$= \frac{{}^{4}C_{1} \times {}^{96}C_{19}}{{}^{100}C_{20}} = 0.42$$

(b) Probability that the sample contains at most one defective item

$$= \frac{{}^{4}C_{0} \times {}^{96}C_{20}}{{}^{100}C_{20}} + \frac{{}^{4}C_{1} \times {}^{96}C_{19}}{{}^{100}C_{20}} = 0.4$$

2.1-12 $$P(X \geq 4 \,|\, X \geq 1) = \frac{P(X \geq 4)}{P(X \geq 1)} = \frac{1 - P(X \leq 3)}{1 - P(X = 0)}$$
$$= \frac{1 - [1 - 1/2 + 1/2 - 1/3 + 1/3 - 1/4 + 1/4 - 1/5]}{1 - [1 - 1/2]} = \frac{2}{5}.$$

2.1-14 $$P(X \geq 1) = 1 - P(X = 0) = 1 - \frac{\binom{3}{0}\binom{17}{5}}{\binom{20}{5}} = 1 - \frac{91}{228} = \frac{137}{228} = 0.60.$$

2.1-16 **(a)** $P(2, 1, 6, 10)$ means that 2 is in position 1 so 1 cannot be selected. Thus
$$P(2, 1, 6, 10) = \frac{\binom{1}{0}\binom{1}{1}\binom{8}{5}}{\binom{10}{6}} = \frac{56}{210} = \frac{4}{15};$$

(b) $$P(i, r, k, n) = \frac{\binom{i-1}{r-1}\binom{1}{1}\binom{n-i}{k-r}}{\binom{n}{k}}.$$

2.2 Mathematical Expectation

2.2-2 $$E(X) = (-2)\left(\frac{9}{27}\right) + (-1)\left(\frac{4}{27}\right) + (0)\left(\frac{1}{27}\right) + (1)\left(\frac{4}{27}\right) + (2)\left(\frac{9}{27}\right) = 0$$
$$E(X^2) = (-2)^2\left(\frac{9}{27}\right) + (-1)^2\left(\frac{4}{27}\right) + (0)^2\left(\frac{1}{27}\right) + (1)^2\left(\frac{4}{27}\right) + (2)^2\left(\frac{9}{27}\right) = \frac{80}{27}$$
$$E(X^2 - 3X + 9) = E(X^2) - 3E(X) + 9 = \frac{80}{27} - 0 + 9 = \frac{323}{27}$$

2.2-4
$$1 = \sum_{x=0}^{6} f(x) = \frac{9}{10} + c\left(\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}\right)$$
$$c = \frac{2}{49};$$
$$E(\text{Payment}) = \frac{2}{49}\left(1 \cdot \frac{1}{2} + 2 \cdot \frac{1}{3} + 3 \cdot \frac{1}{4} + 4 \cdot \frac{1}{5} + 5 \cdot \frac{1}{6}\right) = \frac{71}{490} \text{ units.}$$

2.2-6 Note that $\displaystyle\sum_{x=1}^{\infty} \frac{6}{\pi^2 x^2} = \frac{6}{\pi^2} \sum_{x=1}^{\infty} \frac{1}{x^2} = \frac{6}{\pi^2} \frac{\pi^2}{6} = 1$, so this is a pdf
$$E(X) = \sum_{x=1}^{\infty} x \frac{6}{\pi^2 x^2} = \frac{6}{\pi^2} \sum_{x=1}^{\infty} \frac{1}{x} = +\infty$$
and it is well known that the sum of this harmonic series is not finite.

2.2-8 $E(|X - c|) = \dfrac{1}{7} \displaystyle\sum_{x \in S} |x - c|$, where $S = \{1, 2, 3, 5, 15, 25, 50\}$.
When $c = 5$,
$$E(|X - 5|) = \frac{1}{7}\left[(5 - 1) + (5 - 2) + (5 - 3) + (5 - 5) + (15 - 5) + (25 - 5) + (50 - 5)\right].$$

If c is either increased or decreased by 1, this expectation is increased by $1/7$. Thus $c = 5$, the median, minimizes this expectation while $b = E(X) = \mu$, the mean, minimizes $E[(X-b)^2]$. You could also let $h(c) = E(\,|\,X - c\,|\,)$ and show that $h'(c) = 0$ when $c = 5$.

2.2-10 $$(15)\left(\frac{15}{36}\right) + (-15)\left(\frac{21}{36}\right) = \left(-\frac{5}{2}\right)$$
$$(15)\left(\frac{15}{36}\right) + (-15)\left(\frac{21}{36}\right) = \left(-\frac{5}{2}\right)$$
$$(20)\left(\frac{6}{36}\right) + (-15)\left(\frac{30}{36}\right) = \left(-\frac{55}{6}\right)$$

2.2-12 **(a)** The average class size is $\dfrac{(16)(25) + (3)(100) + (1)(300)}{20} = 50;$

(b)
$$f(x) = \begin{cases} 0.4, & x = 25, \\ 0.3, & x = 100, \\ 0.3, & x = 300, \end{cases}$$

(c) $E(X) = 25(0.4) + 100(0.3) + 300(0.3) = 130.$

2.3 Special Mathematical Expectations

2.3-2 **(a)**
$$\begin{aligned}
\mu &= E(X) \\
&= \sum_{x=1}^{3} x \frac{3!}{x!\,(3-x)!}\left(\frac{1}{4}\right)^x\left(\frac{3}{4}\right)^{3-x} \\
&= 3\left(\frac{1}{4}\right)\sum_{k=0}^{2} \frac{2!}{k!\,(2-k)!}\left(\frac{1}{4}\right)^k\left(\frac{3}{4}\right)^{2-k} \\
&= 3\left(\frac{1}{4}\right)\left(\frac{1}{4}+\frac{3}{4}\right)^2 = \frac{3}{4}; \\
E[X(X-1)] &= \sum_{x=2}^{3} x(x-1) \frac{3!}{x!\,(3-x)!}\left(\frac{1}{4}\right)^x\left(\frac{3}{4}\right)^{3-x} \\
&= 2(3)\left(\frac{1}{4}\right)^2\frac{3}{4} + 6\left(\frac{1}{4}\right)^3 \\
&= 6\left(\frac{1}{4}\right)^2 = 2\left(\frac{1}{4}\right)\left(\frac{3}{4}\right); \\
\sigma^2 &= E[X(X-1)] + E(X) - \mu^2 \\
&= (2)\left(\frac{3}{4}\right)\left(\frac{1}{4}\right) + \left(\frac{3}{4}\right) - \left(\frac{3}{4}\right)^2 \\
&= (2)\left(\frac{3}{4}\right)\left(\frac{1}{4}\right) + \left(\frac{3}{4}\right)\left(\frac{1}{4}\right) = 3\left(\frac{1}{4}\right)\left(\frac{3}{4}\right);
\end{aligned}$$