CHAPTER 4

4.1 (a) Simple events include tossing a head or tossing a tail.
(b) Joint events include tossing two heads (HH), a head followed by a tail (HT), a tail followed by a head (TH), and two tails (TT).
(c) Tossing a tail on the first toss
(d) The sample space is the collection of (HH), (HT), (TH) and (TT).

4.2 (a) Simple events include selecting a red ball. (b) Selecting a white ball
(c) The sample space is the collection of "a red ball being selected" and "a white ball being selected".

4.3 (a) 30/90 = 1/3 = 0.33 (b) 60/90 = 2/3 = 0.67
(c) 10/90 = 1/9 = 0.11 (d) $\frac{30}{90}+\frac{30}{90}-\frac{10}{90}=\frac{50}{90}=\frac{5}{9}=0.556$

4.4 (a) 60/100 = 3/5 = 0.6 (b) 10/100 = 1/10 = 0.1
(c) 35/100 = 7/20 = 0.35 (d) $\frac{60}{100}+\frac{65}{100}-\frac{35}{100}=\frac{90}{100}=\frac{9}{10}=0.9$

4.5 (a) *A priori* (b) Subjective (c) *A priori*
(d) Empirical

4.6 (a) Mutually exclusive, not collectively exhaustive.
(b) Not mutually exclusive, not collectively exhaustive.
(c) Mutually exclusive, not collectively exhaustive.
(d) Mutually exclusive, collectively exhaustive

4.7 (a) The joint probability of mutually exclusive events (being listed on the New York Stock Exchange and NASDAQ) is zero.
(b) The joint probability of the events (owning a smartphone and a tablet) is not zero because a consumer can own both a smartphone and a tablet at the same time.
(c) The joint probability of mutually exclusive events (being a Motorola cellphone and a Samsung cellphone) is zero.
(d) The joint probability of the events (an automobile that is a Toyota and was manufactured in the U.S) is not zero because a Toyota can be manufactured in the U.S.

4.8 (a) "Felt tense or stressed out at work"
(b) "Female felt tense or stressed out at work"
(c) "Did not feel tense or stressed out at work"
(d) "Male felt tense or stressed out a work" is a joint event because it consists of two characteristics.

4.9 (a) *P*(the employed adult felt tense or stressed out at work) = (244+282)/1501 = 0.3504

(b) *P*(the employed adult was a male who felt tense or stressed out at work) = 244/1501 = 0.1627

(c) *P*(the employed adult was a male or felt tense or stressed out at work) = (739+526-244)/1501 = 0.6802

(d) The probability of "the employed adult was a male or felt tense or stressed out at work" includes the probability of "the employed adult felt tense or stressed out at work", the probability of "the employed adult was a male", minus the joint probability of "the employed adult was a male who felt tense or stressed out at work".

4.10 (a) A marketer who plans to increase use of LinkedIn.

(b) A B2B marketer who plans to increase use of LinkedIn.

(c) A marketer who does not plan to increase use of LinkedIn.

(d) A marketer who plans to increase use of LinkedIn and is a B2C marketer is a joint event because it consists of two characteristics, plans to increase use of LinkedIn and is a B2C marketer.

4.11 (a) $P(\text{plans to increase use of LinkedIn}) = \dfrac{2505}{3813} = 0.6570$

(b) $P(\text{B2C marketer}) = \dfrac{1868}{3813} = 0.4899$

(c) $P\left(\text{plans to increase use of LinkedIn or is a B2C marketer}\right)$

$$= \frac{2505}{3813} + \frac{1868}{3813} - \frac{1027}{3813} = 0.8775$$

(d) The probability of "plans to increase use of LinkedIn or is a B2C marketer" includes the probability of "plans to increase use of LinkedIn" and the probability of "is a B2C marketer" minus the probability of "plans to increase use of LinkedIn and is a B2C marketer".

4.12 (a) *P*(indicates analyzing data as critical to his or her job) = 8007/14074 = 0.5689.

(b) *P*(is a manager) = 6264/14074 = 0.4451

(c) *P*(indicates analyzing data as critical to his or her job or is a manager)
= 8007/14074 + 6264/14074 - 3633/14074 = 0.7559

(d) The probability of saying that analyzing data is critical or is a manager includes the probability of saying that analyzing data is critical plus the probability of being a manager minus the joint probability of saying that analyzing data is critical and is a manager.

4.13 (a) *P*(prefers Pepsi) = 175/500 = 0.35

(b) *P*(is male and prefers Pepsi) = 80/500 = 0.16

(c) *P*(is male or prefers Pepsi) = (220+175 –80)/500 = 0.63

(d) The probability of "is male or prefers Pepsi" includes the probability of "is a male", the probability of "prefers Pepsi", minus the joint probability of "is male and prefers Pepsi".

4.14

Enjoy Shopping	Male	Female	Total
Yes	238	276	514
No	304	267	571
Total	542	543	1085

(a) P(enjoys clothes shopping) = 514/1085 = 0.4737
(b) P(female *and* enjoys clothes shopping) = 276/1085 = 0.2544
(c) P(female *or* enjoys clothes shopping) = (543+514-276)/1085= 0.7198
(d) P(male *or* female) = 1085/1085 = 1.00

4.15

Needs Warranty-Related Repair	U.S.	Non-U.S.	Total
Yes	0.025	0.015	0.04
No	0.575	0.385	0.96
Total	0.600	0.400	1.00

(a) P(needs warranty repair) = 0.04
(b) P(needs warranty repair and manufacturer based in U.S.) = 0.025
(c) P(needs warranty repair or manufacturer based in U.S.) = 0.615
(d) P(needs warranty repair or manufacturer not based in U.S.) = 0.425

4.16 (a) $P(A \mid B) = 10/30 = 1/3 = 0.33$
(b) $P(A \mid B') = 20/60 = 1/3 = 0.33$
(c) $P(A' \mid B') = 40/60 = 2/3 = 0.67$
(d) Since $P(A \mid B) = P(A) = 1/3$, events A and B are statistically independent.

4.17 (a) $P(A \mid B) = 10/35 = 2/7 = 0.2857$
(b) $P(A' \mid B') = 35/65 = 7/13 = 0.5385$
(c) $P(A \mid B') = 30/65 = 6/13 = 0.4615$
(d) Since $P(A \mid B) = 0.2857$ and $P(A) = 0.40$, events A and B are not statistically independent.

4.18 $$P(A \mid B) = \frac{P(A \text{ and } B)}{P(B)} = \frac{0.4}{0.8} = \frac{1}{2} = 0.5$$

4.19 $P(A \text{ and } B) = P(A)\,P(B) = 0.7 \bullet 0.6 = 0.42$

4.20 Since $P(A \text{ and } B) = .20$ and $P(A)\,P(B) = 0.12$, events A and B are not statistically independent.

4.21 (a) P(the employed adult was a male | the employed adult felt tense or stressed out at work) = 244/526 = 0.4639
(b) P(he felt tense or stressed out at work | the employed adult is male) = 244/739 = 0.3302
(c) The conditional events are reversed.
(d) Since P(he felt tense or stressed out at work | the employed adult is male) = 0.3302 is not equal to P(he felt tense or stressed out at work) = 0.3504, "are feeling tense or stressed out at work" and "gender" are not statistically independent.

4.22 (a) P(Increased use of LinkedIn | B2B marketer) = 1,478/1,945 = 0.7599
(b) P(Increased use of LinkedIn | B2C marketer) = 1,027/1,868 = 0.5498
(c) P(Increased use of LinkedIn) = 2,505/3,813 = 0.6570, which is not equal to P(Increased use of Linked | B2B marketer) = 0.7599. Therefore, increased use of LinkedIn and business focus are not independent.

4.23 (a) P(he prefers Pepsi | male) = 80/220 = 0.3636
(b) P(she prefers Pepsi | female) = 95/280 = 0.3393
(c) P(he prefers Pepsi | male) = 80/220 = 0.3636
P(prefers Pepsi) = 175/500 = 0.35
Since P(prefers Pepsi) $\neq$ P(prefers Pepsi), preference and gender are not statistically independent.

4.24 (a) P(analyzing data is critical | is staff) = 4374/7810 = 0.5601
(b) P(analyzing data is not critical | is staff) = 3436/7810 = 0.4399
(c) P(analyzing data is critical | is a manager) = 3633/6264 = 0.5800
(d) P(analyzing data is not critical | is a manager) = 2631/6264 = 0.4200

4.25 (a) P(does not enjoy clothes shopping | female) = 267/543 = 0.4917
(b) P(male | enjoys clothes shopping) = 238/514 = 0.4630
(c) Since P(male | enjoys clothes shopping) = 0.4630 and P(male) = 542/1085 or 0.4995, the two events are not statistically independent.

4.26 (a) P(needs warranty repair | manufacturer based in U.S.) = 0.025/0.6 = 0.0417
(b) P(needs warranty repair | manufacturer not based in U.S.) = 0.015/0.4 = 0.0375
(c) Since P(needs warranty repair | manufacturer based in U.S.) = 0.0417 and P(needs warranty repair) = 0.04, the two events are not statistically independent.

4.27 (a) P(higher for the year) = (35+11)/(35+11+5+11) = 0.7419
(b) P(higher for the year | higher first week) = 35/(35+5) = 0.875
(c) Since P(higher for the year) = 0.7419 is not equal to P(higher for the year | higher first week) = 0.875, the two events, "first-week performance" and "annual performance", are not statistically independent.
(d) For 2012, the S&P 500 finished higher after the first five days of trading. It also finished higher for the year than at the end of last year.

4.28 (a) $P(\text{both queens}) = \frac{4}{52} \cdot \frac{3}{51} = \frac{12}{2,652} = \frac{1}{221} = 0.0045$

(b) $P(\text{10 followed by 5 or 6}) = \frac{4}{52} \cdot \frac{8}{51} = \frac{32}{2,652} = \frac{8}{663} = 0.012$

(c) $P(\text{both queens}) = \frac{4}{52} \cdot \frac{4}{52} = \frac{16}{2,704} = \frac{1}{169} = 0.0059$

(d) $P(\text{blackjack}) = \frac{16}{52} \cdot \frac{4}{51} + \frac{4}{52} \cdot \frac{16}{51} = \frac{128}{2,652} = \frac{32}{663} = 0.0483$

4.29 (a) $P(\text{2 right-handed gloves}) = \frac{7}{9}\cdot\frac{6}{8} = \frac{42}{72} = \frac{7}{12} = 0.5833$

(b) $P(\text{1 right-handed and 1 left-handed glove}) = \frac{7}{9}\cdot\frac{2}{8} + \frac{2}{9}\cdot\frac{7}{8} = \frac{28}{72} = \frac{7}{18} = 0.3889$

(c) $P(\text{3 left-handed gloves}) = \left(\frac{2}{9}\right)^3 = 0.01097$

(d) (a) $P(\text{2 right-handed gloves}) = \frac{7}{9}\cdot\frac{7}{9} = \frac{49}{81} = 0.6049$

(b) $P(\text{1 right-handed and 1 left-handed glove}) = 2\left(\frac{7}{9}\right)\left(\frac{2}{9}\right) = 0.3456$

4.30

$$P(B \mid A) = \frac{P(A \mid B)\cdot P(B)}{P(A \mid B)\cdot P(B) + P(A \mid B')\cdot P(B')}$$
$$= \frac{0.8\cdot 0.05}{0.8\cdot 0.05 + 0.4\cdot 0.95} = \frac{0.04}{0.42} = 0.095$$

4.31

$$P(B \mid A) = \frac{P(A \mid B)\cdot P(B)}{P(A \mid B)\cdot P(B) + P(A \mid B')\cdot P(B')}$$
$$= \frac{0.6\cdot 0.3}{0.6\cdot 0.3 + 0.5\cdot 0.7} = \frac{0.18}{0.53} = 0.340$$

4.32 (a) D = has disease T = tests positive

$$P(D \mid T) = \frac{P(T \mid D)\cdot P(D)}{P(T \mid D)\cdot P(D) + P(T \mid D')\cdot P(D')}$$
$$= \frac{0.9\cdot 0.03}{0.9\cdot 0.03 + 0.01\cdot 0.97} = \frac{0.027}{0.0367} = 0.736$$

(b)

$$P(D' \mid T') = \frac{P(T' \mid D')\cdot P(D')}{P(T' \mid D')\cdot P(D') + P(T' \mid D)\cdot P(D)}$$
$$= \frac{0.99\cdot 0.97}{0.99\cdot 0.97 + 0.10\cdot 0.03} = \frac{0.9603}{0.9633} = 0.997$$

4.33 (a) H = husband watching W = wife watching

$$P(H \mid W) = \frac{P(W \mid H)\cdot P(H)}{P(W \mid H)\cdot P(H) + P(W \mid H')\cdot P(H')}$$
$$= \frac{0.4\cdot 0.6}{0.4\cdot 0.6 + 0.3\cdot 0.4} = \frac{0.24}{0.36} = \frac{2}{3} = 0.667$$

(b) $P(W) = 0.24 + 0.12 = 0.36$

4.34 (a) B = Base Construction Co. enters a bid
O = Olive Construction Co. wins the contract

$$P(B' \mid O) = \frac{P(O \mid B') \cdot P(B')}{P(O \mid B') \cdot P(B') + P(O \mid B) \cdot P(B)}$$

$$= \frac{0.5 \cdot 0.3}{0.5 \cdot 0.3 + 0.25 \cdot 0.7} = \frac{0.15}{0.325} = 0.4615$$

(b) $P(O) = 0.175 + 0.15 = 0.325$

4.35 EC = entrepreneurs by choice EN = entrepreneurs by necessity
GE20 = employ 20 or more people within five years
$P(\text{EC}) = .89$ $P(\text{EN}) = .11$ $P(\text{GE20} \mid \text{EN}) = .02$ $P(\text{GE20} \mid \text{EC}) = .14$

(a) $$P(\text{EC} \mid \text{GE20}) = \frac{P(\text{GE20} \mid \text{EC})P(\text{EC})}{P(\text{GE20} \mid \text{EC})P(\text{EC}) + P(\text{GE20} \mid \text{EN})P(\text{EN})}$$

$$= \frac{(.14)(.89)}{(.14)(.89) + (.02)(.11)} = 0.9826$$

(b) Some possible reasons are: (1) entrepreneurs by choice are more ambitious, (2) entrepreneurs by choice choose to be entrepreneurs and are more likely to be risk takers, (3) entrepreneurs by choice have higher expectation and confidence in their ability to grow their business.

4.36 (a) P(huge success | favorable review) = 0.099/0.459 = 0.2157
P(moderate success | favorable review) = 0.14/0.459 = 0.3050
P(break even | favorable review) = 0.16/0.459 = 0.3486
P(loser | favorable review) = 0.06/0.459 = 0.1307
(b) P(favorable review) = 0.99(0.1) + 0.7(0.2) + 0.4(0.4) + 0.2(0.3) = 0.459

4.37 (a) P(A rating | issued by city) = 0.35/0.56 = 0.625
(b) P(issued by city) = 0.5(0.7) + 0.6(0.2) + 0.9(0.1) = 0.56
(c) P(issued by suburb) = 0.4(0.7) + 0.2(0.2) + 0.05(0.1) = 0.325

4.38 $3^{10} = 59049$

4.39 (a) (30)(30)(30) = 27,000
(b) (1/30)(1/30)(1/30) = .000037
(c) In "dial combination", the order of the combination is important while order is irrelevant in the mathematical combination expressed by equation (4.14).

4.40 (a) $2^7 = 128$ (b) $6^7 = 279936$
(c) There are two mutually exclusive and collectively exhaustive outcomes in (a) and six in (b).

4.41 (7)(3)(3) = 63

4.42 $(8)(4)(3)(3) = 288$

4.43 $n! = 4! = (4)(3)(2)(1) = 24$

4.44 $5! = (5)(4)(3)(2)(1) = 120$. Not all these orders are equally likely because the players are different in each team.

4.45 $$\frac{n!}{(n-X)!} = \frac{5!}{1!} = 120$$

4.46 $n! = 6! = 720$

4.47 $$_8C_3 = \frac{8!}{3!(5!)} = 56$$

4.48 $$_{10}C_4 = \frac{10!}{4!(6!)} = 210$$

4.49 $$\frac{n!}{X!(n-X)!} = \frac{7!}{4!(3!)} = \frac{(7)(6)(5)}{(3)(2)(1)} = 35$$

4.50 $$\frac{n!}{X!(n-X)!} = \frac{100!}{2!(98!)} = \frac{(100)(99)}{2} = 4950$$

4.51 $$\frac{n!}{X!(n-X)!} = \frac{20!}{3!(17!)} = \frac{(20)(19)(18)}{(3)(2)(1)} = 1140$$

4.52 With a priori probability, the probability of success is based on prior knowledge of the process involved. With empirical probability, outcomes are based on observed data. Subjective probability refers to the chance of occurrence assigned to an event by a particular individual.

4.53 A simple event can be described by a single characteristic. Joint probability refers to phenomena containing two or more events.

4.54 The general addition rule is used by adding the probability of A and the probability of B and then subtracting the joint probability of A and B.

4.55 Events are mutually exclusive if both cannot occur at the same time. Events are collectively exhaustive if one of the events must occur.

4.56 If events A and B are statistically independent, the conditional probability of event A given B is equal to the probability of A.

4.57 When events A and B are independent, the probability of A and B is the product of the probability of event A and the probability of event B. When events A and B are not independent, the probability of A and B is the product of the conditional probability of event A given event B and the probability of event B.

4.58 Bayes' theorem uses conditional probabilities to revise the probability of an event in the light of new information.

4.59 In Bayes' theorem, the prior probability is an unconditioned probability while the revised probability is the probability of the original event updated in light of some new information.

4.60 (a)

SHARE HEALTH INFORMATION	AGE		
	18–24	45–64	Total
Yes	400	225	625
No	100	275	375
Total	500	500	1,000

(b) Simple event: "Shares health information through social media."
Joint event: "Shares health information through social media and is between 18 and 24 years old."

(c) P(Shares health information through social media) = 625/1,000 = 0.625

(d) P(Shares health information through social media and is in the 45-to-64-year-old group) = 225/1000 = 0.225

(e) P(is in the 46-to-64-year-old group) = 500/1000 = 0.5.
P(Shares health information through social media and is in the 45-to-64-year-old group) is not equal to P(Shares health information through social media) * P(is in the 46-to-64-year-old group); therefore, the events "age group" and "likely to share health information through social media" are not independent.

4.61 (a) P(established economy) = 249/592 = 0.4206

(b) P(established economy or agrees to the statement "My organization uses information talent to make business decisions") = (249+252-122)/592 = 0.6402

(c) P(does not agree with the statement "My organization views HR as a strategic function" and "is from an emerging economy") = 78/592 = 0.1318

(d) P(does not agree with the statement "My organization views HR as a strategic function" or "is from an emerging economy") = (199+249-78)/592 = 0.625

(e) P(emerging economy | does not agree with the statement "My organization views HR as a strategic function.") = 78/199 = 0.3920

(f) Since P(emerging economy | does not agree with the statement "My organization views HR as a strategic function.") $\neq$ P(established economy), "My organization views HR as a strategic function" and the type of economy are not independent.

(g) Since P(established economy | agree with the statement " My organization uses information talent to make business decisions") = 122/252 = 0.4841 $\neq$ P(established economy) = 249/592 = 0.4206, "My organization uses information talent to make business decisions" is independent of the type of economy.

4.62 (a) P(cautious) = 84/200 = 0.42

(b) P(optimistic or cautious) = (42+84)/200 = 126/200 = 0.63

(c) P(male or hunkered-down) = (100+74-33)/200 = 141/200 = 0.705

(d) P(male and hunkered-down) = 33/200 = 0.165

(e) P(optimistic | female) = 16/100 = 0.16

4.63 Contingency table:

		Organization			
		Aspirational	**Experienced**	**Transformed**	
Intense	**Yes**	0.1054	0.2205	0.1488	0.4747
	No	0.2046	0.2295	0.0912	0.5253
		0.31	0.45	0.24	1

P(transformed-user organization | an intense level of focus on using analytics to better understand and connect with customers) = 0.1488/ 0.4747 = 0.3135

4.64 (a) *P*(Big Data as critical to executing a customer-centric program) = 202/447 = 0.4519

(b) *P*(Big Data as critical to executing a customer-centric program | Marketing) = 95/237 = 0.4008

(c) *P*(Big Data as critical to executing a customer-centric program | IT) = 107/210 = 0.5095

(d) *P*(functional silos block aggregation of customer data throughout the organization) = 217/447 = 0.4855

(e) *P*(functional silos block aggregation of customer data throughout the organization | Marketing) = 122/237 = 0.5148

(f) *P*(functional silos block aggregation of customer data throughout the organization | IT) = 95/210 = 0.4524

(g) Identifying "Big Data as critical to executing a customer-centric program" and "executive group" are statistically dependent. Identifying "functional silos block aggregation of customer data throughout the organization" and "executive group" are statistically dependent also. Senior IT executives are more likely to identify Big Data as critical to executing a customer-centric program as compared to senior marketing executives. Senior marketing executives are more likely to identify that functional silos block aggregation of customer data throughout the organization as compared to senior IT executives.

4.65 (a) Let

A_1 = a small business owner uses accounting software

A_2 = a small business owner does not use accounting software

B_1 = a small business owner indicated concern about income tax compliance for their business

B_2 = a small business owner did not indicate concern about income tax compliance for their business

$P(B_1 | A_1)$ = (0.41*0.23)/(0.41*0.23 + 0.58*0.77) = 0.0943/ 0.5409 = 0.1743

(b) Since $P(B_1 | A_1) \neq P(B_1)$, the event of "a small business owner indicated concern about income tax compliance for their business" and "the small business owner uses accounting software" are not statistically independent.