

UNIVARIATE STATISTICAL ANALYSIS

TUTORIAL SESSION 3

PROBABILITY II

Chapter 6

Question 6.40 (page.304) – Characteristics of buyers of Hybrid Honda Civic

Question 6.52 (page.306) – Treatments
Part c only.

Question 6.55 (page.313) – Complementary Therapies and Conventional Medications

Question 6.56 (page. 313) – Centers for Disease Control and Prevention

Suppose that $P(E) = 0.7$, $P(F) = 0.6$, and $P(E \cap F) = 0.54$.

- Calculate $P(E|F)$, the probability that the first airline's flight is fully booked given that the second airline's flight is fully booked. (Hint: See Example 6.12.)
- Calculate $P(F|E)$.

- 6.39 The article "Chances Are You Know Someone with a Tattoo, and He's Not a Sailor" (*Associated Press*, June 11, 2006) included results from a survey of adults aged 18 to 50. The accompanying data are consistent with summary values given in the article.

	At Least One Tattoo	No Tattoo
Age 18–29	18	32
Age 30–50	6	44

Assuming these data are representative of adult Americans and that an adult American is selected at random, use the given information to estimate the following probabilities. (Hint: See Example 6.13.)

- $P(\text{tattoo})$
- $P(\text{tattoo}|\text{age 18–29})$
- $P(\text{tattoo}|\text{age 30–50})$
- $P(\text{age 18–29}|\text{tattoo})$

- 6.40 The accompanying data are from the article "Characteristics of Buyers of Hybrid Honda Civic IMA: Preferences, Decision Process, Vehicle Ownership, and Willingness-to-Pay" (Institute for Environmental Decisions, November 2006). Each of 311 people who purchased a Honda Civic was classified according to sex and whether the car purchased had a hybrid engine or not.

	Hybrid	Not Hybrid
Male	77	117
Female	34	83

Suppose one of these 311 individuals is to be selected at random.

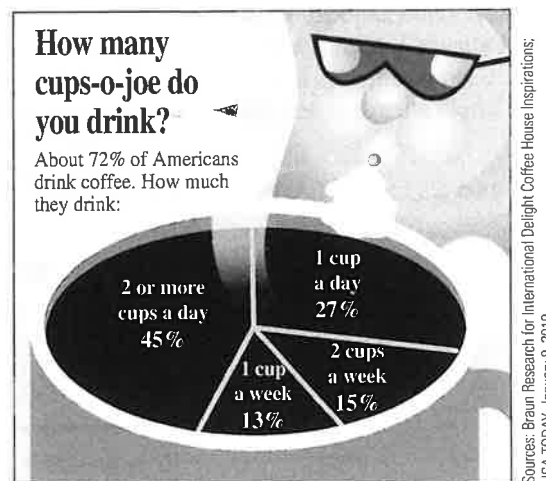
- Find the following probabilities:

- $P(\text{male})$
- $P(\text{hybrid})$
- $P(\text{hybrid}|\text{male})$
- $P(\text{hybrid}|\text{female})$
- $P(\text{female}|\text{hybrid})$

- For each of the probabilities calculated in Part (a), write a sentence interpreting the probability. (Hint: See Example 6.13.)

- 6.41 Using the probabilities calculated in the previous exercise, determine if the probabilities $P(\text{hybrid}|\text{male})$ and $P(\text{male}|\text{hybrid})$ equal. If not, write a sentence or two explaining the difference between these two probabilities.

- 6.42 The following graphical display is similar to one that appeared in *USA TODAY* (January 8, 2010).



Use the information in this display to answer the following questions. Assume that the percentages in the graph are representative of adult Americans.

- What is the probability that a randomly selected adult American drinks coffee?
 - The display associates 45% with the category "two or more cups a day." For the chance experiment that consists of selecting an adult American at random, is 0.45 the probability that the selected individual drinks two or more cups of coffee a day, or is it the conditional probability that the selected individual drinks two or more cups a day given that he or she drinks coffee? Explain.
- 6.43 The article "Americans Growing More Concerned About Head Injuries in Football" (theharrispoll.com, December 21, 2015) describes a survey of 2096 adult Americans. Survey participants were asked if they were football fans and also if they agreed or disagreed that the rules that the National Football League adopted in 2010 designed to limit head injuries have been effective. Data from the survey are summarized in the table below.

	Agree	Disagree	Total
Football Fan	693	523	1,216
Not a Football Fan	229	651	880
Total	922	1,174	2,096

Suppose that a survey participant is to be selected at random. Consider the following events:

A = event selected participant agrees that the rules have been effective

D = event selected participant disagrees that the rules have been effective

F = event selected participant is a football fan

Calculate the following probabilities

- $P(A)$
- $P(D)$
- $P(A|F)$
- $P(A|F^c)$

- 6.49** The report “2015 Utah Seat Belt Use Survey” (Utah Department of Public Safety—Highway Safety Office, September 14, 2015) stated that based on observing a large number of vehicle occupants, the estimated percentage of Utah drivers and passengers who wear seatbelts is 87.2%. The report also gave information on seat belt use by sex and by whether the vehicle is traveling in an urban or rural area. The information in the following table is consistent with summary values given in the report.

	Urban Areas		Rural Areas	
	Male	Female	Male	Female
Seat belt	871	928	770	837
No Seat Belt	129	72	230	163

Assume that these data are representative of drivers and passengers in Utah. Consider the following conclusion:

Females are more likely to wear seat belts than males in both urban and rural areas. The difference in the percentage of females and the percentage of males who wear seat belts is greater for rural areas than for urban areas.

Provide a justification for this conclusion. Use the information in the table to calculate relevant probabilities.

- 6.50** The National Highway Traffic Safety Administration requires each U.S. state to carry out an observational study to assess the level of seat belt use in the state. The report “2015 Utah Seat Belt Use Survey” (Utah Department of Public Safety, September 14, 2015) summarized data from the study done in Utah. The proportions in the accompanying table are based on observations of over 25,000 drivers and passengers.

	Uses Seatbelt	Does Not Use Seat Belt
Male	0.423	0.077
Female	0.452	0.048

Assume that these proportions are representative of adults in Utah and that an adult from Utah is selected at random.

- What is the probability that the selected adult uses a seat belt?
 - What is the probability that the selected adult uses a seat belt given that the individual selected is male?
- 6.51** Use the information given in the previous exercise to answer the following questions.
- What is the probability that the selected adult does not use a seat belt given that the selected individual is female?

- What is the probability that the selected individual is female given that the selected individual does not use a seat belt?
- Are the probabilities from Parts (a) and (b) equal? Write a couple of sentences explaining why or why not.

- 6.52** The paper “Good for Women, Good for Men, Bad for People: Simpson’s Paradox and the Importance of Sex-Specific Analysis in Observational Studies” (*Journal of Women’s Health and Gender-Based Medicine* [2001]: 867–872) described the results of a medical study in which one treatment was shown to be better for men and better for women than a competing treatment. However, if the data for men and women are combined, it appears as though the competing treatment is better.

To see how this can happen, consider the accompanying data tables constructed from information in the paper. Subjects in the study were given either Treatment A or Treatment B, and survival was noted. Let S be the event that a patient selected at random survives, A be the event that a patient selected at random received Treatment A, and B be the event that a patient selected at random received Treatment B.

- The following table summarizes data for men and women combined:

	Survived	Died	Total
Treatment A	215	85	300
Treatment B	241	59	300
Total	456	144	

- Find $P(S)$.
 - Find $P(S|A)$.
 - Find $P(S|B)$.
 - Which treatment appears to be better?
- Now consider the summary data for the men who participated in the study:

	Survived	Died	Total
Treatment A	120	80	200
Treatment B	20	20	40
Total	140	100	

- Find $P(S)$.
- Find $P(S|A)$.
- Find $P(S|B)$.
- Which treatment appears to be better?

- Now consider the summary data for the women who participated in the study:

	Survived	Died	Total
Treatment A	95	5	100
Treatment B	221	39	260
Total	316	144	

- c. Still assuming independence, calculate the probability that exactly one of the next two calls will be for medical assistance. (Hint: There are two different possibilities. The one call for medical assistance might be the first call, or it might be the second call.)
- d. Do you think that it is reasonable to assume that the requests made in successive calls are independent? Explain.

6.55 The paper “Predictors of Complementary Therapy Use Among Asthma Patients: Results of a Primary Care Survey” (*Health and Social Care in the Community* [2008]: 155–164) included the accompanying table. The table summarizes the responses given by 1077 asthma patients to two questions:

Question 1: Do conventional asthma medications usually help your asthma symptoms?

Question 2: Do you use complementary therapies (such as herbs, acupuncture, aroma therapy) in the treatment of your asthma?

	Doesn't Use Complementary Therapies	Does Use Complementary Therapies
Conventional Medications Usually Help	816	131
Conventional Medications Usually Do Not Help	103	27

Consider a chance experiment that consists of randomly selecting one of the 1077 survey participants.

- a. Construct a joint probability table by dividing the count in each cell of the table by the sample size $n = 1077$. (Hint: See Example 6.16.)
- b. The joint probability in the upper left cell of the table from Part (a) is $\frac{816}{1077} = 0.758$. This represents the probability of conventional medications usually help *and* does not use complementary therapies. Interpret the other three probabilities in the joint probability table of Part (a).
- c. Are the events
- CH = event that the selected participant reports that conventional medications usually help
and
- CT = event that the selected participant reports using complementary therapies
- independent events?

Use a probability argument to justify your choice. (Hint: See Example 6.18.)

6.56 The report “TV Drama/Comedy Viewers and Health Information” (cdc.gov/healthcommunication/pdf/healthstyles_2005.pdf, retrieved April 25, 2017) describes the results of a large survey that was conducted for the Centers for Disease Control and Prevention (CDC). The sample was selected in a way that the CDC believed would result in a sample that was representative of adult Americans.

One question on the survey asked respondents if they had learned something new about a health issue or disease from a TV show in the previous 6 months. Data from the survey was used to estimate the following probabilities, where

L = event that a randomly selected adult American reports learning something new about a health issue or disease from a TV show in the previous 6 months

and

F = event that a randomly selected adult American is female

$$P(L) = 0.58 \quad P(L \cap F) = 0.31$$

Assume that $P(F) = 0.5$. Are the events L and F independent events? Use probabilities to justify your answer.

6.57 The report “Great Jobs, Great Lives. The Relationship Between Student Debt, Experiences and Perceptions of College Worth” (Gallup-Purdue Index 2015 Report) gave information on the percentage of recent college graduates (those graduating between 2006 and 2015, inclusive) who strongly agree with the statement “My college education was worth the cost.” Suppose that a college graduate will be selected at random, and consider the following events:

A = event that the selected graduate strongly agrees that education was worth the cost
 N = event that the selected graduate finished college with no student debt
 H = event that the selected graduate finished college with high student debt (over \$50,000)

The following probability estimates were given in the report:

$$P(A) = 0.38 \quad P(A|N) = 0.49 \quad P(A|H) = 0.18$$

- a. Interpret the value of $P(A|N)$.
- b. Interpret the value of $P(A|H)$.
- c. Are the events A and H independent? Justify your answer.

6.58 In a small city, approximately 15% of those eligible are called for jury duty in any one calendar year. People are selected for jury duty at random from those eligible, and the same individual cannot be called more than once in the same year.