# Chapter 4: Probability

## Section 4.1 Contingency Tables

### Exercises 4.1

1. A recent survey asked a random sample of PCC students if they are currently experiencing food insecurity and if they are currently experiencing housing insecurity. Fill in the missing entries of the contingency table below. ADD

|  |  |  |  |
| --- | --- | --- | --- |
|  | Food Insecure | Not Food Insecure | Total |
| Housing Insecure |  | 60 |  |
| Not Housing Insecure |  | 460 | 760 |
| Total | 680 |  |  |

1. A recent survey asked a random sample of PCC students if they have purchased food from the cafeteria in the last week, and if they purchased their textbooks through the bookstore. Fill in the missing entries of the contingency table below. ADD

|  |  |  |  |
| --- | --- | --- | --- |
|  | Bookstore | No Bookstore | Total |
| Cafeteria |  |  | 375 |
| No Cafeteria |  | 135 |  |
| Total | 630 |  | 850 |

1. A recent survey asked PCC students if they regularly eat breakfast and if they regularly floss their teeth Use the completed Venn Diagram to fill in the corresponding contingency table. ADD

|  |  |  |  |
| --- | --- | --- | --- |
|  | Breakfast | No Breakfast | Total |
| Floss |  |  |  |
| No Floss |  |  |  |
| Total |  |  |  |

8

*Breakfast*

*Floss*

33

12

49

1. A recent survey asked PCC students if they used an Apple phone, and if the regularly used a Chromebook outside of school. Use the completed Venn Diagram to fill in the corresponding contingency table. ADD

|  |  |  |  |
| --- | --- | --- | --- |
|  | Chromebook | No Chromebook | Total |
| Apple |  |  |  |
| No Apple |  |  |  |
| Total |  |  |  |

*Apple*

*Chromebook*

120

65

85

45

1. Use the following information to complete the contingency table: ADD

|  |  |  |  |
| --- | --- | --- | --- |
|  | A | Not A | Total |
| B |  |  |  |
| Not B |  |  |  |
| Total |  |  |  |

* P(A and B) = 10/75
* P(A) = 40/75
* P(not B) = 45/75

1. Use the following information to complete the contingency table: ADD

|  |  |  |  |
| --- | --- | --- | --- |
|  | A | Not A | Total |
| B |  |  |  |
| Not B |  |  |  |
| Total |  |  |  |

* P(A given B) = 30/80
* P(Not A and Not B ) = 10/120

1. A professor gave a test to students in a morning class and the same test to the afternoon class. The grades are summarized below. EDIT!

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | A | B | C | Total |
| Morning Class | 8 | 18 | 13 | 39 |
| Afternoon Class | 10 | 4 | 12 | 26 |
| Total | 18 | 22 | 25 | 65 |

If one student was chosen at random:

* 1. What is the probability they were in the morning class?
  2. What is the probability they earned a C?
  3. What is the probability that they earned an A and they were in the afternoon class?
  4. What is the probability that they earned an A given they were in the morning class?
  5. What is the probability that they were in the morning class or they earned a B?

1. A professor surveyed students in her morning and afternoon Math 105 class, and asked what their class standing was. The class standings are summarized below: ADD

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Freshman | Sophomore | Junior | Senior | Total |
| Morning Class | 12 | 5 | 7 | 8 | 32 |
| Afternoon Class | 5 | 13 | 8 | 2 | 28 |
| Total | 17 | 18 | 15 | 10 | 60 |

If one student was chosen at random:

* 1. What is the probability they were in the morning class?
  2. What is the probability they were a Freshman?
  3. What is the probability that they were a Senior and they were in the afternoon class?
  4. What is the probability that they were a Sophomore given they were in the morning class?
  5. What is the probability that they were in the morning class or they were a Junior?

1. The contingency table below shows the number of credit cards owned by a group of individuals below the age of 35 and above the age of 35.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Zero | One | Two or more | Total |
| Between the ages of 18-35 | 9 | 5 | 19 | 33 |
| Over age 35 | 18 | 10 | 20 | 48 |
| Total | 27 | 15 | 39 | 81 |

If one person was chosen at random:

* 1. What is the probability they had no credit cards?
  2. What is the probability they had one credit card?
  3. What is the probability they had no credit cards and is over 35?
  4. What is the probability they are between the ages of 18 and 35, or have zero credit cards? EDIT!
  5. What is the probability they had no credit cards given that they are between the ages of 18 and 35?
  6. What is the probability they have no credit cards given that they are over age 35?
  7. Does it appear that having no credit cards depends on age? Or are they independent? Use probability to support your claim.

Delete current #4 and #5 and #6

1. The following contingency table provides data from a sample of 6,224 individuals who were exposed to smallpox in Boston.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Inoculated | Not Inoculated | Total |
| Lived | 238 | 5136 | 5374 |
| Died | 6 | 844 | 850 |
| Total | 244 | 5980 | 6224 |

(Data taken from Mostly Harmless Probability & Statistics by Rachel Webb)

* 1. What is the probability that a person was inoculated?
  2. What is the probability that a person lived?
  3. What is the probability that a person died or was inoculated?
  4. What is the probability that a person died given they were inoculated?
  5. What is the probability that a person died given they were not inoculated?
  6. Does it appear that survival depended on if a person were inoculated? Or are they independent? Use probability to support your claim.

1. The contingency table below shows the survival data for the passengers of the Titanic.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **First** | **Second** | **Third** | **Crew** | **Total** |
| **Survive** | 203 | 118 | 178 | 212 | 711 |
| **Not Survive** | 122 | 167 | 528 | 673 | 1490 |
| **Total** | 325 | 285 | 706 | 885 | 2201 |

1. What is the probability that a passenger did not survive?
2. What is the probability that a passenger was crew?
3. What is the probability that a passenger was first class and did not survive?
4. What is the probability that a passenger did not survive or was crew?
5. What is the probability that a passenger survived given they were first class?
6. What is the probability that a passenger survived given they were second class?
7. What is the probability that a passenger survived given they were third class?
8. Does it appear that survival depended on the passenger’s class? Or are they independent? Use probability to support your claim.
9. The following table shows the utility patents granted for a specific year.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Corporation | Government | Individual | Total |
| United States | 45% | 2% | 8% | 55% |
| Foreign | 41% | 1% | 3% | 45% |
| Total | 86% | 3% | 11% | 100% |

* 1. What is the probability that a patent is foreign and from the government?
  2. What is the probability that a patent is from the U.S. and from a corporation?
  3. What is the probability that a patent is foreign or from the government?
  4. What is the probability that a patent is from the U.S. given it is from an individual?
  5. What is the probability that a patent is foreign given it is from the government?

1. There is a 15% chance that a shopper entering a computer store will purchase a computer, a 25% chance they will purchase a game/software, and there is a 10% chance they will purchase both a computer and a game/software.
   1. Create a contingency table for the information.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Game/Software | No Game/Software | Total |
| Computer |  |  |  |
| No Computer |  |  |  |
| Total |  |  |  |

* 1. What is the probability that a shopper will not purchase a computer and will not purchase a game/software?
  2. What is the probability that a shopper will purchase a computer or purchase a game/software?
  3. What is the probability that a shopper will purchase a game/software given they have purchased a computer?
  4. What is the probability that a shopper will purchase a game/software given they did not purchase a computer?
  5. Does it appear that purchasing a game/software depends on whether the shopper purchased a computer? Or are they independent? Use probability to support your claim.

1. A fitness center coach kept track over the last year of whether members stretched before they exercised, and whether or not they sustained an injury. Among the 400 members, 322 stretched before they exercised, 327 did not sustain an injury, and 270 both stretched and did not sustain an injury.
   1. Create a contingency table for the information.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Injury | No Injury | Total |
| Stretched |  |  |  |
| Did not stretch |  |  |  |
| Total |  |  |  |

* 1. What is the probability that a member sustained an injury?
  2. What is the probability that a member sustained an injury and did not stretch?
  3. What is the probability that a member stretched or did not sustain an injury?
  4. What is the probability that a member sustained an injury given they stretched?
  5. What is the probability that a member sustained an injury given they did not stretch?
  6. Does it appear that sustaining an injury depends on whether the member stretches before exercising? Or are they independent? Use probability to support your claim.

1. Among the 95 books on a bookshelf, 72 are fiction, 28 are hardcover, and 87 are fiction or hardcover.
   1. Create a contingency table for the information.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Hardcover | Paperback | Total |
| Fiction |  |  |  |
| Nonfiction |  |  |  |
| Total |  |  |  |

* 1. What is the probability that a book is non-fiction and paperback?
  2. What is the probability that a book is fiction given it is hardcover?

1. After finishing the course, among the 32 students in a Math 105 class, 25 could successfully construct a contingency table, 27 passed the class, and 29 could successfully construct a contingency table or passed the class.
   1. Create a contingency table for the information.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Contingency Table | No Contingency Table | Total |
| Pass |  |  |  |
| Not Pass |  |  |  |
| Total |  |  |  |

* 1. What is the probability that a student passed and could not successfully construct a contingency table?
  2. What is the probability that a student passed given they could not successfully construct a contingency table?

### Solutions



|  |  |  |  |
| --- | --- | --- | --- |
|  | Food Insecure | Not Food Insecure | Total |
| Housing Insecure | **380** | 60 | **440** |
| Not Housing Insecure | **300** | 460 | 760 |
| Total | 680 | **520** | **1200** |



|  |  |  |  |
| --- | --- | --- | --- |
|  | Bookstore | No Bookstore | Total |
| Cafeteria | **290** | **85** | 375 |
| No Cafeteria | **340** | 135 | **475** |
| Total | 630 | **220** | 850 |



|  |  |  |  |
| --- | --- | --- | --- |
|  | Breakfast | No Breakfast | Total |
| Floss | 12 | 49 | 61 |
| No Floss | 3 | 8 | 11 |
| Total | 15 | 57 | 72 |



|  |  |  |  |
| --- | --- | --- | --- |
|  | Chromebook | No Chromebook | Total |
| Apple | 65 | 120 | 185 |
| No Apple | 85 | 45 | 130 |
| Total | 150 | 165 | 315 |



|  |  |  |  |
| --- | --- | --- | --- |
|  | A | Not A | Total |
| B | 10 | 20 | 30 |
| Not B | 20 | 25 | 45 |
| Total | 30 | 45 | 75 |



|  |  |  |  |
| --- | --- | --- | --- |
|  | A | Not A | Total |
| B | 30 | 50 | 80 |
| Not B | 30 | 10 | 40 |
| Total | 60 | 60 | 120 |

3. 7. Yes, it appears that having no credit cards depends on age. The probability of having no credit cards for people over age 35 is significantly greater than the probability of having no credits for people between the ages of 18 and 35.
4. 6. Yes, it appears that survival was dependent if a person was inoculated. The percentage of deaths among the not inoculated group was nearly six times greater than the percentage of deaths among the inoculated group.
5. 8. Yes, it does appear that survival depended on the passenger’s class. The probability of survival for first class passengers is significantly greater than the probability of survival for second class passengers and is more than double the probability of survival for third class passengers.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Game/Software | No Game/Software | Total |
| Computer | 10% | 5% | 15% |
| No Computer | 15% | 70% | 85% |
| Total | 25% | 75% | 100% |

* 5. Purchasing a game/software and purchasing a computer appear to be depended. The probability of purchasing a game/software for computer buyers was almost 50% greater than the probability of purchasing a game/software among customers who did not purchase a computer.



|  |  |  |  |
| --- | --- | --- | --- |
|  | Injury | No Injury | Total |
| Stretched | 52 | 270 | 322 |
| Did not stretch | 21 | 57 | 78 |
| Total | 73 | 327 | 400 |

* 6. It appears that sustaining an injury is dependent on whether the member stretches before exercising. The probability of sustaining an injury among members who did not stretch before exercising was significantly higher than the probability of sustaining an injury among members who stretched before exercising.



|  |  |  |  |
| --- | --- | --- | --- |
|  | Hardcover | Paperback | Total |
| Fiction | 13 | 59 | 72 |
| Nonfiction | 15 | 8 | 23 |
| Total | 28 | 67 | 95 |







|  |  |  |  |
| --- | --- | --- | --- |
|  | Contingency Table | No Contingency Table | Total |
| Pass | 23 | 4 | 27 |
| Not Pass | 2 | 3 | 5 |
| Total | 25 | 7 | 32 |