1. Alicia will select a student at random from her biology class. You are given the following facts about the students in her class.

- Twenty percent are females and juniors.
- Fifteen percent are males and juniors.
- Twenty-five percent are females and not juniors.

Use this information to calculate the following probabilities. The student Alicia selects is:

(a) A junior.
(b) A junior or a female. (Remember: Or means and/or.)
(c) A male.

2. Kalinda will select a student at random from her criminal justice class. You are given the following facts about the students in her class.

- Ten percent are females and veterans (military service).
- Fifty percent are males.
- Seventy percent are not veterans.

Use this information to calculate the following probabilities. The student Kalinda selects is:

(a) A veteran.
(b) A veteran or a female. (Remember: Or means and/or.)
(c) A female and not a veteran.

3. The 1,000 students at a small state university are classified according to two features. Partial results are in the table below.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>190</td>
<td>140</td>
<td>120</td>
<td>150</td>
<td>600</td>
</tr>
<tr>
<td>Male</td>
<td>80</td>
<td>100</td>
<td>90</td>
<td>130</td>
<td>400</td>
</tr>
<tr>
<td>Total</td>
<td>270</td>
<td>240</td>
<td>210</td>
<td>280</td>
<td>1000</td>
</tr>
</tbody>
</table>

Consider the Chance Mechanism of selecting one student at random from the population of 1,000 students. Define the following events:

- $A$: The student selected is in year 1.
- $B$: The student selected is in year 3 or year 4.
- $C$: The student selected is female.

Use this information to obtain the following probabilities.

(a) $P(A \text{ or } C)$.
(b) $P(BC^c)$.
(c) $P([A \text{ or } B]^c)$.

4. The 1,000 students at a small state university are classified according to three features. Partial results are in the table below.

<table>
<thead>
<tr>
<th>Code</th>
<th>Resident?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
</tr>
</tbody>
</table>

The code is:

- 1: Female Natural Science Major
2: Male Natural Science Major  
3: Female Social Science Major  
4: Male Social Science Major

The Chance Mechanism is that one student is selected at random from the population of 1000 students. Define the following events.

- A: The selected student is a resident.
- B: The selected student is female.
- C: The selected student is a natural science major.

Calculate the following probabilities.

(a) \( P(A) \).
(b) \( P(C) \)
(c) \( P(AC) \)
(d) \( P([A \text{ or } B]^c) \)

5. Consider a sample space with three members: 1, 2 and 3. We are given: \( P(1) = 0.2, P(2) = 0.3, P(3) = 0.5 \). Assume that we have i.i.d. trials.

(a) Calculate \( P(X_1 = X_2) \).
(b) Calculate \( P(X_1 + X_2 + X_3 = 8) \).

6. Consider a sample space with four members: 0, 1, 3 and 5, with probabilities 0.1, 0.2, 0.3 and 0.4, respectively. Thus, this is not the equally likely case. Assume i.i.d. trials. Define \( X_1, X_2 \) and \( X_3 \) in the usual way.

Calculate \( P(X_1 + X_2 = 6) \).

7. Refer to the previous question. Now assume that the four possible values, 0, 1, 3 and 5, are equally likely.

Calculate

\[ P(X_1 + X_2 + X_3 = 9) \].

8. Consider a sample space with five members: 1, 2, 3, 4 and 5. Assume the ELC and i.i.d. trials.

(a) Calculate \( P(X_1 = 2X_2) \).
(b) Calculate \( P(X_1 + X_2 + X_3 = 4) \).

9. Let \( X \sim \text{Bin}(2400, 0.40) \). I want to use the normal curve website to approximate \( P(900 \leq X < 985) \). I want to use the continuity correction. Suppose we go to the website; tell me which number to place in each of the boxes below.

(a) Mean.
(b) Sd (standard deviation).
(c) Do I select Above, Below or Between?
(d) For my choice in (c), what number(s) do I place in the box(es)?

10. Refer to the previous question. Answer the four questions for \( P(X < 950) \).

11. Shawn likes to shoot free throws. For this problem, assume that Shawn’s shots are Bernoulli Trials with \( p = 0.57 \). On each of three days next week, Monday through Wednesday, Shawn will shoot exactly four free throws.

(a) On any given day, we say that the event ‘Guster’ has occurred if, and only if:

- Shawn obtains the sequence SFSF or
- Shawn obtains the sequence FSFS.

Calculate the probability of a Guster.
(b) Let \( Y \) denote the total number of Gusters that Shawn obtains on the three days next week.

Calculate \( P(Y = 1) \).
12. Carlton likes to shoot free throws. For this problem, assume that Carlton’s shots are Bernoulli Trials with $p = 0.62$. On each of five days next week, Monday through Friday, Carlton will shoot exactly three free throws.

(a) On any given day, we say that the event ‘Juliet’ has occurred if, and only if, Carlton obtains the sequence a Success, a Failure and a Success, in that order. Calculate the probability of a Juliet on any given day.

(b) Let $Y$ denote the total number of Julietts that Carlton obtains on the five days next week. Calculate $P(Y = 2)$.

13. Ellen plans to observe $n = 9$ Bernoulli trials. Consider the following events.

- $A$: The first trial will be a success.
- $B$: The last trial will be a success.
- $C$: The first five trials will have a total of exactly three successes.
- $D$: The entire sequence of $n = 9$ trials will have a total of exactly six successes.

Ellen wants to compute several probabilities, listed below. For each part, write down the probability that Ellen wants. Your answer should include $p$’s and $q$’s and, possibly, factorials. You must leave the $p$’s and $q$’s alone (because I am not telling you their values), but you need to convert the factorials to integers.

(a) $P(AB)$.

(b) $P(AC)$.

(c) $P(ABCD)$.

14. Fran plans to observe $n = 10$ Bernoulli trials. Consider the following events.

- $A$: The first trial will be a success.
- $B$: The last trial will be a success.
- $C$: The first six trials will have a total of exactly four successes.
- $D$: The entire sequence of $n = 10$ trials will have a total of exactly seven successes.

Fran wants to compute several probabilities, listed below. For each part, write down the probability that Fran wants. Your answer should include $p$’s and $q$’s and, possibly, factorials. You must leave the $p$’s and $q$’s alone (because I am not telling you their values), but you need to convert the factorials to integers.

(a) $P(AB)$.

(b) $P(AC)$.

(c) $P(ABCD)$.

15. Diane performs 880 Bernoulli Trials and obtains a total of 220 successes. Find the 80% two-sided confidence interval for $p$. Use the approximate method.

16. Diana performs 1350 Bernoulli Trials and obtains a total of 756 successes. Find the 99% two-sided confidence interval for $p$. Use the approximate method.

17. Hazel observes $n$ Bernoulli trials and calculates the approximate 95% confidence interval for $p$. She obtains

$\hat{p} \pm 0.0365$.

Isaac observes $2n$ Bernoulli trials and obtains the same value for $\hat{p}$ as Hazel did. Calculate the 90% confidence interval for $p$ for the combined sample of $3n$ Bernoulli trials.
18. Herman observes \( n \) Bernoulli trials and calculates the approximate 95% confidence interval for \( p \). She obtains

\[
\hat{p} \pm 0.0777.
\]

Drew observes \( 4n \) Bernoulli trials and obtains the same value for \( \hat{p} \) as Herman did. Calculate the 98% confidence interval for \( p \) for the combined sample of \( 5n \) Bernoulli trials.

19. You are given the following information.
The exact 90% upper bound for a Poisson \( \theta \) from \( X = 4 \) successes is \([0, 7.9936] \).
Tom performs \( n = 5000 \) BT’s and obtains \( X = 4 \) successes. Find an approximate 90% upper bound for \( p \).

20. I went to the online exact confidence interval site and entered \( X = 6 \) and \( n = 1500 \) for the Binomial. It gave me \([0, 0.0070]\) as the exact one-sided upper 90% confidence interval for \( p \).

Later I observed a Poisson Process for three hours and counted six successes. Find an approximate one-sided upper 90% confidence interval for the rate per hour for the Poisson Process.

21. Sally observes a Poisson Process for 100 hours and counts 225 successes. Use the SNC approximation to obtain a 95% CI for the rate per hour.

22. Molly observes a Poisson Process for 270 minutes and counts 630 successes. Calculate the 98% two-sided confidence interval for the rate per hour. Use the approximate method.

23. Ernie performs a Goodness of Fit Test with no parameters estimated and \( k = 7 \) categories. He decides to use \( \alpha = 0.10 \) for his significance level.

He goes to the Chi-Squared calculator and finds the following display.

\[
\text{degrees of freedom} = \quad 8
\]

\[
\text{Area right of} \quad = \quad
\]

Help Ernie by filling in two numbers above so that he can obtain his critical region by clicking on the ‘Compute!’ box.

24. Bert performs a Goodness of Fit Test with \( df = 8 \) (filled in below). From his data, he calculates \( \chi^2 = 17.37 \).

He goes to the Chi-Squared calculator and finds the following display.

\[
\text{degrees of freedom} = \quad 8
\]

\[
\text{Area right of} \quad = \quad
\]

Help Bert by filling in one number above so that he can obtain his P-value by clicking on the ‘Compute!’ box.

25. Carl performs a hypothesis test and obtains a P-value equal to 0.1234.

(a) Give me any one value of \( \alpha \) that would lead to Carl rejecting the null hypothesis.

(b) Give me any one value of \( \alpha \) that would lead to Carl failing to reject the null hypothesis.

26. For each of the four situations below, (a)–(d), determine which of the following three statements is correct.

A: Reject the null hypothesis.
B: Fail to reject the null hypothesis.
C: More information is needed.

(a) Alan rejects the null hypothesis for $\alpha = 0.05$. What would be his decision for $\alpha = 0.10$?

(b) Alan rejects the null hypothesis for $\alpha = 0.05$. What would be his decision for $\alpha = 0.01$?

(c) Beth fails to reject the null hypothesis for $\alpha = 0.05$. What would be her decision for $\alpha = 0.10$?

(d) Beth fails to reject the null hypothesis for $\alpha = 0.05$. What would be her decision for $\alpha = 0.01$?

27. Three researchers—named Xena, Yolanda and Zeke—each collect data and perform a Goodness-of-Fit test. They all have the same number of degrees of freedom. Below are their values of $\chi^2$:

<table>
<thead>
<tr>
<th>Name</th>
<th>$\chi^2$</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xena</td>
<td>3.652</td>
<td></td>
</tr>
<tr>
<td>Yolanda</td>
<td>2.871</td>
<td></td>
</tr>
<tr>
<td>Zeke</td>
<td>4.623</td>
<td></td>
</tr>
</tbody>
</table>

The researchers’ P-values are: 0.0991, 0.1611 and 0.2380. Match each researcher with his/her P-value and place your answer in the table above.

28. You are given the following fact about P-values for any Goodness-of-Fit test:

For a fixed value of $\chi^2$, the P-value is an increasing function of the number of degrees of freedom; i.e. as the number of degrees of freedom is increased, the P-value increases.

Each of three researchers, denoted $A$, $B$ and $C$, perform a Goodness-of-Fit test. You are given the following facts:

- $A$ and $B$ have the same number of degrees of freedom.
- The number of degrees of freedom for $C$ is larger than the number of degrees of freedom for $A$.
- $B$ and $C$ have the same value of $\chi^2$; their common value is smaller than $A$’s value of $\chi^2$.

The three P-values for these researchers are: 0.0460, 0.1116 and 0.3062. Match each P-value with its researcher.

<table>
<thead>
<tr>
<th>Name</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td></td>
</tr>
<tr>
<td>$B$</td>
<td></td>
</tr>
<tr>
<td>$C$</td>
<td></td>
</tr>
</tbody>
</table>

29. Below are tables (4, 5 and 6) from three different studies. Note that at least one of these tables is the answer to more than one of the following six questions.

(a) Which table is for the study that had an S on its first trial and an F on its last trial?

(b) Which table is for the study that had an F on its first trial and an S on its last trial?

(c) Which table is for the study that had an F on its first and last trials?

(d) Which table is for the study in which the majority of trials yielded an S?
(e) Which table is for the study in which the proportion of successes after an S was smaller than the proportion of successes after an F?

(f) Which table is for the study in which the proportion of successes after an S was equal to the proportion of successes after an F?

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev.</td>
<td>S</td>
</tr>
<tr>
<td>S</td>
<td>100</td>
</tr>
<tr>
<td>F</td>
<td>200</td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev.</td>
<td>S</td>
</tr>
<tr>
<td>S</td>
<td>123</td>
</tr>
<tr>
<td>F</td>
<td>123</td>
</tr>
<tr>
<td>Total</td>
<td>246</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 6</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prev.</td>
<td>S</td>
</tr>
<tr>
<td>S</td>
<td>152</td>
</tr>
<tr>
<td>F</td>
<td>122</td>
</tr>
<tr>
<td>Total</td>
<td>274</td>
</tr>
</tbody>
</table>

30. Tom performs 100 dichotomous trials. Below are some facts about his data.

- Tom obtained a total of exactly 70 successes.
- Tom’s first trial was a success and his last trial was a failure.
- Trials 6–9 and 52–57 were all failures, but, otherwise Tom never had two successive failures.

Determine the one-step memory table for Tom’s data.

**Answer:**

31. Katy observes 14 dichotomous trials and obtains the following results:

S S F S F S F S S S S S F F.

Note that there is a total of nine successes in these data.

Determine the correct values to put into Katy’s one-step memory table below.

<table>
<thead>
<tr>
<th>Previous</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial</td>
<td>S</td>
</tr>
<tr>
<td>S</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

32. Below are tables (1 and 2) from two different studies. Note that the answers to the following two questions are not necessarily different tables.

(a) Which table is for the study that had an S on its first trial and an F on its last trial?

(b) Which table is for the study that provided evidence that the subject performed better (S’s are good) after an S than after an F?
33. Below are tables (3 and 4) from two different studies. Note that the answers to the following two questions are not necessarily different tables.

(a) Which table is for the study that had the same response on its first and last trials?

(b) Which table is for the study that provided evidence that the subject performed worse (F’s are bad) after an S than after an F?

34. I cast my round-cornered white die 1,000 times and obtained the frequencies given below.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>181</td>
<td>139</td>
<td>135</td>
<td>160</td>
<td>141</td>
<td>244</td>
</tr>
</tbody>
</table>

For each of the questions below, you may use these data, if needed for your answer. Also, remember that for a die, ‘smaller than 2,’ for example, means 1.

(a) Fiona assumes that the die is balanced (i.e. the six possible outcomes are equally likely to occur) and defines a success to be any outcome smaller than 3. Calculate Fiona’s 95% PI for the number of her successes in 600 future casts of the die.

(b) George does not assume that the die is balanced and he defines a success to be any outcome smaller than 4. Calculate George’s 95% PI for the number of his successes in 2000 future casts of the die.

35. I cast my round-cornered white die 1,000 times and obtained the frequencies given in the previous question.

(a) Nancy assumes that the die is balanced (i.e. the six possible outcomes are equally likely to occur) and defines a success to be any outcome smaller than 4. Calculate Nancy’s 95% PI for the number of her successes in 900 future casts of the die.

(b) Ron does not assume that the die is balanced and he defines a success to be any outcome smaller than 3. Calculate Ron’s 95% PI for the number of his successes in 2000 future casts of the die.
1. I recommend constructing the following table, where $A$ corresponds to female and $B$ corresponds to junior.

<table>
<thead>
<tr>
<th></th>
<th>$B$</th>
<th>$B^c$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>0.20</td>
<td>0.25</td>
<td>0.45</td>
</tr>
<tr>
<td>$A^c$</td>
<td>0.15</td>
<td>0.40</td>
<td>0.55</td>
</tr>
<tr>
<td>Total</td>
<td>0.35</td>
<td>0.65</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Next, by addition and subtraction, we get the completed table:

<table>
<thead>
<tr>
<th></th>
<th>$B$</th>
<th>$B^c$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>0.20</td>
<td>0.25</td>
<td>0.45</td>
</tr>
<tr>
<td>$A^c$</td>
<td>0.15</td>
<td>0.40</td>
<td>0.55</td>
</tr>
<tr>
<td>Total</td>
<td>0.35</td>
<td>0.65</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Now it is easy to answer the questions.

(a) $P(B) = 0.35$.
(b) $P(A \text{ or } B) = 0.45 + 0.15 = 0.60$.
(c) $P(A^c) = 0.55$.

2. I recommend constructing the following table, where $A$ corresponds to female and $B$ corresponds to veteran.

<table>
<thead>
<tr>
<th></th>
<th>$B$</th>
<th>$B^c$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>0.10</td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>$A^c$</td>
<td>0.50</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>Total</td>
<td>0.70</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Next, by addition and subtraction, we get the completed table:

<table>
<thead>
<tr>
<th></th>
<th>$B$</th>
<th>$B^c$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>0.10</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>$A^c$</td>
<td>0.20</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>Total</td>
<td>0.30</td>
<td>0.70</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Now it is easy to answer the questions.

(a) $P(B) = 0.30$.
(b) $P(A \text{ or } B) = 0.50 + 0.20 = 0.70$.
(c) $P(AB^c) = 0.40$.

3. (a) $P(A \text{ or } C) = 0.27 + 0.60 - 0.19 = 0.68$.
(b) $P(BC^c) = 0.09 + 0.13 = 0.22$. Note that you may not simply multiply. If you have i.i.d. trials then you may multiply, but we do not have i.i.d. trials, we just have two features per person.
(c) $P([A \text{ or } B]^c) = 1 - P(A \text{ or } B)$. Next,

$$P(A \text{ or } B) = 0.27 + 0.49 = 0.76$$

4. (a) There are 700 residents, so $P(A) = \frac{700}{1000} = 0.70$.
(b) By adding, there are 650 students belonging to Code 1 or 2; thus,

$$P(C) = 0.65$$

(c) The event $AC$ consists of students who are in the first row and in either Code 1 or 2: a total of 410 students. Thus,

$$P(AC) = 0.41$$

Note: Many students (in my class) simply multiplied the answers from (a) and (b). This would be valid if we had i.i.d. trials, but we don’t.

(d) This question was tricky. Many students invented a way to represent the event of interest. Sadly, these inventions were wrong. Here is what I suggest. By the complement rule, the answer I want is one minus the probability of $(A \text{ or } B)$. Next,

$$P(A \text{ or } B) = P(A) + P(B) - P(AB).$$
We already know that \( P(A) = 0.70 \). Next, note that a female is either Code 1 or 3; thus, \( P(B) = 0.60 \). Finally, \( AB \) consists of all persons in the first row who are in Code 1 or 3: 420 persons. Thus, \( P(A \text{ or } B) = 0.70 + 0.60 - 0.42 = 0.88 \).

Finally, the answer I want is \( 1 - 0.88 = 0.12 \).

5. For both parts we need to write the desired event with a combination of ‘ands’ and ‘ors.’

(a) \( P(X_1 = X_2) = P(11 \text{ or } 22 \text{ or } 33) = P(11) + P(22) + P(33) = (0.2)(0.2) + (0.3)(0.3) + (0.5)(0.5) = 0.38 \).

(b) \( P(X_1 + X_2 + X_3 = 8) = P(233 \text{ or } 323 \text{ or } 332) = 3(0.3)(0.5)(0.5) = 0.225 \).

6. Two 3’s will give a sum of 6, as will either of the two arrangements of a 1 and a 5. Thus, the probability of interest is \( (0.3)(0.3) + 2(0.2)(0.4) = 0.25 \).

7. Here are the ways to get a sum of 9: Three 3’s; or a 1, a 3 and a 5. Thus, the probability of interest is \( 7/64 = 0.1094 \).

8. (a) \( P(X_1 = 2X_2) = P(21 \text{ or } 42) = P(21) + P(42) = 2/25 = 0.08 \).

(b) There is only one way to obtain a sum of 4: two 1’s and a 2. Thus, the probability of interest is \( 3/125 = 0.024 \).

9. (a) The mean is \( np = 2400(0.4) = 960 \).

(b) The Sd is \( \sqrt{960(0.6)} = 24 \).

(c) Between.

(d) 899.5 and 984.5.

10. (a) The mean is \( np = 2400(0.4) = 960 \).

(b) The Sd is \( \sqrt{960(0.6)} = 24 \).

(c) Below.

(d) 949.5.

11. (a) The probability of a Guster is: \( pqpq + qpqp = 2p^2q^2 = 0.1201 \).

(b) The \( P(Y = 1) \) is \( \frac{3!}{1!2!}(0.1201)(0.8799)^2 = 0.2788 \).

12. (a) The probability of a Juliet is: \( pqp = (0.62)(0.38)(0.62) = 0.1461 \).

(b) The \( P(Y = 2) \) is \( \frac{5!}{2!3!}(0.1461)^2(0.8539)^3 = 0.1328 \).

13. (a) \( pq \).

(b) Events \( A \) and \( C \) both involve trial 1, so we need to rewrite \( AC \) without overlap. On reflection \( AC \) occurs if, and only if, the first trial is a success and trials 2–5 yield a total of exactly two successes. This probability is \( \frac{4!}{2!2!}p^2q^2 = 6p^3q^2 \).
(c) Events \(A, B, C\) and \(D\) involve many common trials, so we need to rewrite \(ABCD\) without overlap. On reflection \(ABCD\) occurs if, and only if, the first trial is a success and trials 2–5 yield a total of exactly two successes and trials 6–8 yield a total of exactly three successes and trial 9 is a failure. This probability is

\[
p \frac{4!}{2!2!} p^2 q^2 p^3 q = 6p^6 q^3.
\]

14. (a) \(P(AB) = p^2\).

(b) We define a new event \(E\): trials 2 through 6 have a total of exactly three successes. Then, \(P(AC) = P(AE)\).

We may use the multiplication rule for \(AE\) because their trials do not overlap. Thus,

\[
P(AE) = p \left( \frac{5!}{3!2!} p^3 q^2 \right) = 10p^4 q^2.
\]

(c) The approach to (c) is just an extension of the approach to (b). Define \(E\) as in (b). Define the event \(G\): trials 7 through 9 have a total of exactly two successes. Then,

\[
P(ABCD) = P(ABEG).
\]

We may use the multiplication rule for \(ABEG\) because their trials do not overlap. Thus,

\[
P(ABEG) = p^2 \frac{5!}{3!2!} p^3 q^2 \frac{3!}{2!1!} p^2 q = 30p^7 q^3.
\]

15. First, \(\hat{p} = 220/880 = 0.25\). The CI is

\[
0.250 \pm 1.282 \sqrt{[0.25(0.75)]/880} = 0.250 \pm 0.019 = [0.231, 0.269].
\]

16. First, \(\hat{p} = 756/1350 = 0.56\). The CI is

\[
0.560 \pm 2.576 \sqrt{[0.56(0.44)]/1350} = 0.560 \pm 0.035 = [0.525, 0.595].
\]

17. First,

\[
\sqrt{(\hat{p}\hat{q})/n} = 0.0365/1.96 = 0.018622.
\]

Thus,

\[
\sqrt{(\hat{p}\hat{q})/3n} = 0.018622/\sqrt{3} = 0.010751
\]

and the new CI is

\[
\hat{p} \pm 1.645(0.010751) = \hat{p} \pm 0.0177.
\]

18. First,

\[
1.96 \sqrt{\hat{p}\hat{q}/n} = 0.0777.
\]

Thus,

\[
\sqrt{\hat{p}\hat{q}/n} = 0.0777/1.96 = 0.0396.
\]

Thus,

\[
\sqrt{\hat{p}\hat{q}/5n} = \sqrt{\hat{p}\hat{q}/n}/\sqrt{5} = 0.0396/\sqrt{5} = 0.0177.
\]

The half width for the new CI is

\[
2.326(0.0177) = 0.0412.
\]

The new CI is \(\hat{p} \pm 0.0412\).

19. The key is to approximate the Bin(5000,\(p\)) distribution with the Poisson(\(\theta\)), with \(\theta = 5000p\). The exact 90% upper bound gives us:

\[
\theta \leq 7.9936.
\]

Thus, we know that we have approximately 90% confidence that

\[
5000p \leq 7.9936 \text{ or } p \leq 0.001599.
\]
20. We begin with the confidence bound
\[ p \leq 0.0070. \]
This gives
\[ np = 1500p \leq 1500(0.0070) = 10.5. \]
Next, as an approximation, replace \( np \) by \( \theta \); this gives
\[ \theta \leq 10.5. \]
Now, recall that \( \theta = 3\lambda \). Make this substitution,
\[ 3\lambda \leq 10.5 \text{ or } \lambda \leq 3.5. \]

21. Let \( \lambda \) denote the rate per hour. Sally observes a Poisson(\( \theta \)), with \( \theta = 100\lambda \). The CI for \( \theta \) is
\[ 225 \pm 1.96\sqrt{225} = 225 \pm 29.4 = [195.6, 254.4]. \]
Divide the endpoints by 100 and get the CI for \( \lambda \): [1.956, 2.544].

22. Let \( \lambda \) denote the rate per hour. Molly observes a Poisson(\( \theta \)), with \( \theta = 4.5\lambda \). The CI for \( \theta \) is
\[ 630 \pm 2.326\sqrt{630} = 630 \pm 58.4 = [571.6, 688.4]. \]
Divide the endpoints by 4.5 and get the CI for \( \lambda \): [127.0, 153.0].

23. Type 6 in the top box, 0.10 in the lower right box and click on ‘Compute’. The number that appears in the lower left box is the critical value.

24. Type 17.37 in the lower left box and click on ‘Compute’. The number that appears in the lower right box is the P-value.

25. (a) Any \( \alpha \geq 0.1234 \) works.
(b) Any \( \alpha < 0.1234 \) works.

26. (a) A.
(b) C.
(c) C.
(d) B.

27. The largest \( \chi^2 \) gives the smallest P-value and the smallest \( \chi^2 \) gives the largest P-value.

28. A and B have the same value for df and the \( \chi^2 \) for A is larger than the \( \chi^2 \) for B. Thus, A’s P-value is smaller than B’s P-value.

Next, B and C have the same value of \( \chi^2 \), and C’s df is larger than B’s df. Thus, from the fact, B’s P-value is smaller than C’s P-value.

Putting this together, A has the smallest P-value and C has the largest P-value.

29. (a) Table 5.
(b) Table 6.
(c) Table 4.
(d) Table 6.
(e) Table 6.
(f) Table 4.

30. The completed table is below.

<table>
<thead>
<tr>
<th>Previous Trial</th>
<th>Current Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>F</td>
</tr>
<tr>
<td>S</td>
<td>48</td>
</tr>
<tr>
<td>F</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>69</td>
</tr>
</tbody>
</table>

31. The completed table is below.
32. (a) Table 2.
(b) Table 2.

33. (a) Table 4.
(b) Table 3.

34. (a) Because Fiona assumes that \( p = \frac{2}{6} \) is known, the data are irrelevant. Next, \( m = 600 \), giving the following prediction interval.

\[
600\left(\frac{2}{6}\right) \pm 1.96\sqrt{600\left(\frac{2}{6}\right)\left(\frac{4}{6}\right)} = 200 \pm 22.6 = [177, 223].
\]

(b) For George, \( m = 2000, n = 1000 \) and \( x = 181 + 139 + 135 = 455 \). Thus, \( \hat{p} = 0.455 \) and \( \hat{q} = 0.545 \). Thus, his prediction interval is:

\[
910\pm1.96\sqrt{910(0.545)\sqrt{1 + (2000/1000)}} = 910 \pm 75.6 = [834, 986].
\]

35. (a) Because Nancy assumes that \( p = \frac{3}{6} \) is known, the data are irrelevant. Next, \( m = 900 \), giving the following prediction interval.

\[
900\left(\frac{3}{6}\right) \pm 1.96\sqrt{900\left(\frac{3}{6}\right)\left(\frac{3}{6}\right)} = 450 \pm 29.4 = [421, 479].
\]