**5a: Develop a joint probability table for these data.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Business** | **Engineering** | **Other** | **Totals** |
| **Full-Time** | 0.2697 | 0.1510 | 0.1923 | **0.6130** |
| **Part-Time** | 0.1149 | 0.1280 | 0.1487 | **0.3870** |
| **Totals** | **0.3847** | **0.2743** | **0.3410** | **1.0000** |

**5b: Use the marginal probabilities of undergraduate major (business, engineering, or other) to comment on which undergraduate major produces the most potential MBA students.**

The marginal probabilities of undergraduate major (business, engineering, or other) are derived by summing the joint probabilities in the corresponding columns. The marginal probabilities indicate that 38.47% of potential MBA students are from the business undergraduate major, 27.43% are from the engineering undergraduate major and 34.1% are from other undergraduate majors. Therefore, the business undergraduate major produces the most potential MBA students.

**5c: If a student intends to attend classes full time in pursuit of an MBA degree, what is the probability that the student was an undergraduate engineering major?**

The probability that the student studied full time and was an undergraduate engineering major is 0.151.

**5d. If a student was an undergraduate business major, what is the probability that the student intends to attend classes full time in pursuit of an MBA degree?**

The probability that the student was an undergraduate business major and attended full class time is 0.2697/0.613 = 0.44.

**5e. Let *F* denote the event that the student intends to attend classes full time in pursuit of an MBA degree, and let *B* denote the event that the student was an undergraduate business major. Are events *F* and *B* independent? Justify your answer.**

No. *P (F)*= 0.613 and P (F|B) = 0.2697 meaning that the probability that a student pursues an undergraduate business major is determined by whether the student attends classes full-time or part time. Because *P* (F|B) is not equal to *P* (B), then events *F* and *B* are dependent if the probabilities had been equal, then the two events would be independent.

**Part B of Chapter 5#Hamilton County Judges Case**

1. **The probability of cases being appealed and reversed in the three different courts.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Appealed Cases** | **Reversed Cases** | **Total Cases Disposed** | **Total** |
| Common Pleas Court | 0.0095 | 0.0011 | 0.2368 | **0.2473** |
| Domestic Relations Court | 0.0006 | 0.0001 | 0.1643 | **0.1650** |
| Municipal Court | 0.0027 | 0.0006 | 0.5844 | **0.5877** |
| **Total** | **0.0128** | **0.0017** | **0.9855** | **1.0000** |

The table shows the conditional probabilities of the data. The probability of cases being appealed in the Common Pleas Court is 0.0095, 0.0006 in the Domestic Relations Court ad 0.0027in the Municipal Court. The probability of cases being reversed in the Common Pleas court is 0.0011, 0.0001 in the Domestic Relations Court and 0.0006 in the Municipal Court.

1. **The probability of a case being appealed for each judge.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Judge** | **Total Cases Disposed** | **Appealed Cases** | **Reversed Cases** | **Probability of Case Appeal** |
| Fred Cartolano | 3037 | 137 | 12 | 0.04300 |
| Thomas Crush | 3372 | 119 | 10 | 0.03399 |
| Patrick Dinkelacker | 1258 | 44 | 8 | 0.03359 |
| Timothy Hogan | 1954 | 60 | 7 | 0.02969 |
| Robert Kraft | 3138 | 127 | 7 | 0.03881 |
| William Mathews | 2264 | 91 | 18 | 0.03835 |
| William Morrissey | 3032 | 121 | 22 | 0.03811 |
| Norbert Nadeal | 2959 | 131 | 20 | 0.04212 |
| Arthur Ney Jr | 3219 | 125 | 14 | 0.03722 |
| Richard Niehaus | 3353 | 137 | 16 | 0.03908 |
| Thomas Nurre | 3000 | 121 | 6 | 0.03870 |
| John O'Connor | 2969 | 129 | 12 | 0.04148 |
| Robert Ruehlman | 3205 | 145 | 18 | 0.04305 |
| J. Howard Sundermann | 955 | 60 | 10 | 0.05854 |
| Ann Marie Tracey | 3141 | 127 | 13 | 0.03871 |
| Ralph Winkler | 3089 | 88 | 6 | 0.02765 |
| Penelope Cunnigham | 2729 | 7 | 1 | 0.00256 |
| Patrick Dinkelacker | 6001 | 19 | 4 | 0.00315 |
| Debora Gaines | 8799 | 48 | 9 | 0.00542 |
| Ronald Panioto | 12970 | 32 | 3 | 0.00246 |
| Mike Allen | 6149 | 43 | 4 | 0.00694 |
| Nadine Allen | 7812 | 34 | 6 | 0.00433 |
| Timothy Black | 7954 | 41 | 6 | 0.00512 |
| David Davis | 7736 | 43 | 5 | 0.00552 |
| Leslie Isaiah Gaines | 5282 | 35 | 13 | 0.00657 |
| Karla Grady | 5253 | 6 | 0 | 0.00114 |
| Deidra Hair | 2532 | 5 | 0 | 0.00197 |
| Dennis Helmick | 7900 | 29 | 5 | 0.00366 |
| Timothy Hogan | 2308 | 13 | 2 | 0.00560 |
| James Patric Kenney | 2798 | 6 | 1 | 0.00214 |
| Joseph Luebbers | 4698 | 25 | 8 | 0.00528 |
| William Mallory | 8277 | 38 | 9 | 0.00457 |
| Melba Marsh | 8219 | 34 | 7 | 0.00412 |
| Beth Mattingly | 2971 | 13 | 1 | 0.00436 |
| Albert Mestemaker | 4975 | 28 | 9 | 0.00559 |
| Mark Painter | 2239 | 7 | 3 | 0.00311 |
| Jack Roesen | 7790 | 41 | 13 | 0.00523 |
| Mark Schweikert | 5403 | 33 | 6 | 0.00606 |
| David Stockdale | 5371 | 22 | 4 | 0.00408 |
| John A. West | 2797 | 4 | 2 | 0.00143 |

The probability of a case being appealed for each judge is shown in the last column.

1. **The probability of a case being reversed for each judge**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Judge** | **Total Cases Disposed** | **Appealed Cases** | **Reversed Cases** | **Probability of Case Appeal** | **Probability of Case Reversal** |
| Fred Cartolano | 3037 | 137 | 12 | 0.0430 | 0.0038 |
| Thomas Crush | 3372 | 119 | 10 | 0.0340 | 0.0029 |
| Patrick Dinkelacker | 1258 | 44 | 8 | 0.0336 | 0.0061 |
| Timothy Hogan | 1954 | 60 | 7 | 0.0297 | 0.0035 |
| Robert Kraft | 3138 | 127 | 7 | 0.0388 | 0.0021 |
| William Mathews | 2264 | 91 | 18 | 0.0383 | 0.0076 |
| William Morrissey | 3032 | 121 | 22 | 0.0381 | 0.0069 |
| Norbert Nadeal | 2959 | 131 | 20 | 0.0421 | 0.0064 |
| Arthur Ney Jr | 3219 | 125 | 14 | 0.0372 | 0.0042 |
| Richard Niehaus | 3353 | 137 | 16 | 0.0391 | 0.0046 |
| Thomas Nurre | 3000 | 121 | 6 | 0.0387 | 0.0019 |
| John O'Connor | 2969 | 129 | 12 | 0.0415 | 0.0039 |
| Robert Ruehlman | 3205 | 145 | 18 | 0.0431 | 0.0053 |
| J. Howard Sundermann | 955 | 60 | 10 | 0.0585 | 0.0098 |
| Ann Marie Tracey | 3141 | 127 | 13 | 0.0387 | 0.0040 |
| Ralph Winkler | 3089 | 88 | 6 | 0.0276 | 0.0019 |
| Penelope Cunnigham | 2729 | 7 | 1 | 0.0026 | 0.0004 |
| Patrick Dinkelacker | 6001 | 19 | 4 | 0.0032 | 0.0007 |
| Debora Gaines | 8799 | 48 | 9 | 0.0054 | 0.0010 |
| Ronald Panioto | 12970 | 32 | 3 | 0.0025 | 0.0002 |
| Mike Allen | 6149 | 43 | 4 | 0.0069 | 0.0006 |
| Nadine Allen | 7812 | 34 | 6 | 0.0043 | 0.0008 |
| Timothy Black | 7954 | 41 | 6 | 0.0051 | 0.0007 |
| David Davis | 7736 | 43 | 5 | 0.0055 | 0.0006 |
| Leslie Isaiah Gaines | 5282 | 35 | 13 | 0.0066 | 0.0024 |
| Karla Grady | 5253 | 6 | 0 | 0.0011 | 0.0000 |
| Deidra Hair | 2532 | 5 | 0 | 0.0020 | 0.0000 |
| Dennis Helmick | 7900 | 29 | 5 | 0.0037 | 0.0006 |
| Timothy Hogan | 2308 | 13 | 2 | 0.0056 | 0.0009 |
| James Patric Kenney | 2798 | 6 | 1 | 0.0021 | 0.0004 |
| Joseph Luebbers | 4698 | 25 | 8 | 0.0053 | 0.0017 |
| William Mallory | 8277 | 38 | 9 | 0.0046 | 0.0011 |
| Melba Marsh | 8219 | 34 | 7 | 0.0041 | 0.0008 |
| Beth Mattingly | 2971 | 13 | 1 | 0.0044 | 0.0003 |
| Albert Mestemaker | 4975 | 28 | 9 | 0.0056 | 0.0018 |
| Mark Painter | 2239 | 7 | 3 | 0.0031 | 0.0013 |
| Jack Roesen | 7790 | 41 | 13 | 0.0052 | 0.0017 |
| Mark Schweikert | 5403 | 33 | 6 | 0.0061 | 0.0011 |
| David Stockdale | 5371 | 22 | 4 | 0.0041 | 0.0007 |
| John A. West | 2797 | 4 | 2 | 0.0014 | 0.0007 |

The probability of a case being reversed for each judge is shown in the last column.

1. **The probability of reversal given an appeal for each judge**

|  |  |  |  |
| --- | --- | --- | --- |
| **Judge** | **Probability of Case Appeal** | **Probability of Case Reversal** | **Probability of Case Reversal Given Appeal** |
| Fred Cartolano | 0.0430 | 0.0038 | 0.0876 |
| Thomas Crush | 0.0340 | 0.0029 | 0.0840 |
| Patrick Dinkelacker | 0.0336 | 0.0061 | 0.1818 |
| Timothy Hogan | 0.0297 | 0.0035 | 0.1167 |
| Robert Kraft | 0.0388 | 0.0021 | 0.0551 |
| William Mathews | 0.0383 | 0.0076 | 0.1978 |
| William Morrissey | 0.0381 | 0.0069 | 0.1818 |
| Norbert Nadeal | 0.0421 | 0.0064 | 0.1527 |
| Arthur Ney Jr | 0.0372 | 0.0042 | 0.1120 |
| Richard Niehaus | 0.0391 | 0.0046 | 0.1168 |
| Thomas Nurre | 0.0387 | 0.0019 | 0.0496 |
| John O'Connor | 0.0415 | 0.0039 | 0.0930 |
| Robert Ruehlman | 0.0431 | 0.0053 | 0.1241 |
| J. Howard Sundermann | 0.0585 | 0.0098 | 0.1667 |
| Ann Marie Tracey | 0.0387 | 0.0040 | 0.1024 |
| Ralph Winkler | 0.0276 | 0.0019 | 0.0682 |
| Penelope Cunnigham | 0.0026 | 0.0004 | 0.1429 |
| Patrick Dinkelacker | 0.0032 | 0.0007 | 0.2105 |
| Debora Gaines | 0.0054 | 0.0010 | 0.1875 |
| Ronald Panioto | 0.0025 | 0.0002 | 0.0938 |
| Mike Allen | 0.0069 | 0.0006 | 0.0930 |
| Nadine Allen | 0.0043 | 0.0008 | 0.1765 |
| Timothy Black | 0.0051 | 0.0007 | 0.1463 |
| David Davis | 0.0055 | 0.0006 | 0.1163 |
| Leslie Isaiah Gaines | 0.0066 | 0.0024 | 0.3714 |
| Karla Grady | 0.0011 | 0.0000 | 0.0000 |
| Deidra Hair | 0.0020 | 0.0000 | 0.0000 |
| Dennis Helmick | 0.0037 | 0.0006 | 0.1724 |
| Timothy Hogan | 0.0056 | 0.0009 | 0.1538 |
| James Patric Kenney | 0.0021 | 0.0004 | 0.1667 |
| Joseph Luebbers | 0.0053 | 0.0017 | 0.3200 |
| William Mallory | 0.0046 | 0.0011 | 0.2368 |
| Melba Marsh | 0.0041 | 0.0008 | 0.2059 |
| Beth Mattingly | 0.0044 | 0.0003 | 0.0769 |
| Albert Mestemaker | 0.0056 | 0.0018 | 0.3214 |
| Mark Painter | 0.0031 | 0.0013 | 0.4286 |
| Jack Roesen | 0.0052 | 0.0017 | 0.3171 |
| Mark Schweikert | 0.0061 | 0.0011 | 0.1818 |
| David Stockdale | 0.0041 | 0.0007 | 0.1818 |
| John A. West | 0.0014 | 0.0007 | 0.5000 |

The probability of a case being reversed given appeal for each judge is shown in the last column.

**5.Rank the judges within each court. State the criteria you used and provide a rational for your choice.**

The ranking was based on the probability of case reversal given appeal for each judge. A high probability implies that the judge has a high likelihood of making mistakes in determining cases. Therefore, the judge with the lowest probability has the best performance.

The ranking of the judges in the Common Pleas Court is shown in the table below.

|  |  |  |
| --- | --- | --- |
| **Judge** | **Probability of Case Reversal Given Appeal** | **Ranking** |
| Thomas Nurre | 0.0496 | 1 |
| Robert Kraft | 0.0551 | 2 |
| Ralph Winkler | 0.0682 | 3 |
| Thomas Crush | 0.0840 | 4 |
| Fred Cartolano | 0.0876 | 5 |
| John O'Connor | 0.0930 | 6 |
| Ann Marie Tracey | 0.1024 | 7 |
| Arthur Ney Jr | 0.1120 | 8 |
| Timothy Hogan | 0.1167 | 9 |
| Richard Niehaus | 0.1168 | 10 |
| Robert Ruehlman | 0.1241 | 11 |
| Norbert Nadeal | 0.1527 | 12 |
| J. Howard Sundermann | 0.1667 | 12 |
| Patrick Dinkelacker | 0.1818 | 14 |
| William Morrissey | 0.1818 | 15 |
| William Mathews | 0.1978 | 16 |

The table shows that the top three judges in the Common Pleas Court are: Thomas Nurre, Robert Kraft and Ralph Winkler. The worst performing judge in this court was William Matthews.

The ranking of the judges in the Domestic Relations Court is shown below.

|  |  |  |
| --- | --- | --- |
| **Judge** | **Probability of Case Reversal Given Appeal** | **Ranking** |
| Ronald Panioto | 0.0938 | 1 |
| Penelope Cunnigham | 0.1429 | 2 |
| Debora Gaines | 0.1875 | 3 |
| Patrick Dinkelacker | 0.2105 | 4 |

The table shows that the best performing judge in the Domestic Relations Court was Ronald Paniota. The worst performing judge in this court was Patrick Dinkelacker.

The ranking of the judges in the Municipal Court is shown below.

|  |  |  |
| --- | --- | --- |
| **Judge** | **Probability of Case Reversal Given Appeal** | **Ranking** |
| Karla Grady | 0.0000 | 1 |
| Deidra Hair | 0.0000 | 2 |
| Beth Mattingly | 0.0769 | 3 |
| Mike Allen | 0.0930 | 4 |
| David Davis | 0.1163 | 5 |
| Timothy Black | 0.1463 | 6 |
| Timothy Hogan | 0.1538 | 7 |
| James Patric Kenney | 0.1667 | 8 |
| Dennis Helmick | 0.1724 | 9 |
| Nadine Allen | 0.1765 | 10 |
| Mark Schweikert | 0.1818 | 11 |
| David Stockdale | 0.1818 | 12 |
| Melba Marsh | 0.2059 | 13 |
| William Mallory | 0.2368 | 14 |
| Jack Roesen | 0.3171 | 15 |
| Joseph Luebbers | 0.3200 | 16 |
| Albert Mestemaker | 0.3214 | 17 |
| Leslie Isaiah Gaines | 0.3714 | 18 |
| Mark Painter | 0.4286 | 19 |
| John A. West | 0.5000 | 20 |

The top three best performing judges in the Municipal Court were Karla Grady, Deidra Hair, and Beth Mattingly. The worst performing judge in this court was John A. West.

**Part A of Chapter 7#1**

**1a: Develop a scatter chart with weight as independent variable. What does the scatter chart indicate about the relationship between the weight and price of these bicycles?**

The large values of weight appear to be associated with small values of price, and small values of weight appear to be associated with large values of price. Therefore, the chart indicates a negative correlation between weight and price of the bicycles.

**1b. Use the data to develop an estimated regression equation that could be used to estimate the price for a bicycle, given its weight. What is the estimated regression model?**

The chart above displays the estimated regression equation for predicting the price of a bicycle, given its weight. The estimated regression equation is

yi=28818-1439xi

Where y is price ($) and x is weight (lb)

**Part A of Chapter 7#Alumni Giving**

**1: Use methods of descriptive statistics to summarize the data.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ***Graduation Rate*** |  | ***% of Classes Under 20*** |  | ***Student-Faculty Ratio*** |  | ***Alumni Giving Rate*** |  |
| Mean | 83.04 | Mean | 55.73 | Mean | 11.54 | Mean | 29.27 |
| Median | 83.50 | Median | 59.50 | Median | 10.50 | Median | 29.00 |
| Standard Deviation | 8.61 | Standard Deviation | 13.19 | Standard Deviation | 4.85 | Standard Deviation | 13.44 |
| Minimum | 66.00 | Minimum | 29.00 | Minimum | 3.00 | Minimum | 7.00 |
| Maximum | 97.00 | Maximum | 77.00 | Maximum | 23.00 | Maximum | 67.00 |

The results indicate that the graduation rate ranged from 66- 97%. The average graduation rate stood at 83.04% (*SD*=8.61). Ranging between 29% and 77%, the average % of classes under 20 was 55.73 (*SD*=13.19). The results also show that the mean student-faculty ratio was 11.54 (*SD=*4.85) and ranged from 3 to 23. In addition, the alumni giving rate ranged from 7 to 67% with an average of 29.27% (*SD*=13.44).

**2: Develop an estimated simple linear regression model that can be used to predict the alumni giving rate, given the graduation rate. Discuss your findings.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT | |  |  |  |  |  |
|  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.76 |  |  |  |  |  |
| R Square | 0.57 |  |  |  |  |  |
| Adjusted R Square | 0.56 |  |  |  |  |  |
| Standard Error | 8.89 |  |  |  |  |  |
| Observations | 48 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |
| Regression | 1 | 4852.46 | 4852.46 | 61.34 | 0.00 |  |
| Residual | 46 | 3639.02 | 79.11 |  |  |  |
| Total | 47 | 8491.48 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -68.76 | 12.58 | -5.46 | 0.00 | -94.09 | -43.43 |
| Graduation Rate | 1.18 | 0.15 | 7.83 | 0.00 | 0.88 | 1.48 |

The estimated regression model is:

**Alumni Giving Rate = -68.76 + 1.18 (Graduation Rate)**

The R-square or coefficient of determination associated with the model is 0.57, indicating that 57% of variation in alumni giving rate can be accounted for by the graduation rate.

The ANOVA results, *F* (1, 46) = 61.34, *p* < 0.05 indicate that the coefficient of determination was significantly different from zero.

The interpretation of the constant term or the estimated y-intercept is not meaningful as it is a result of extrapolation.

The model indicates that the mean alumni giving rate will increase by 1.18 percent when the graduation rate increases by 1 percent. The *p*-value for the *t* test of graduation rate (*p* value = 0.00) is less than the 0.05 level of significance implying that graduation rate has a statistically significant relationship with alumni giving rate.

**3: Develop an estimated multiple linear regression model that could be used to predict the alumni giving rate using Graduation Rate, % of Classes Under 20, and Student/Faculty Ratio as independent variables. Discuss your findings.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT | |  |  |  |  |  |
|  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.84 |  |  |  |  |  |
| R Square | 0.70 |  |  |  |  |  |
| Adjusted R Square | 0.68 |  |  |  |  |  |
| Standard Error | 7.61 |  |  |  |  |  |
| Observations | 48 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |
| Regression | 3 | 5943.53 | 1981.18 | 34.21 | 0.00 |  |
| Residual | 44 | 2547.95 | 57.91 |  |  |  |
| Total | 47 | 8491.48 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -20.72 | 17.52 | -1.18 | 0.24 | -56.03 | 14.59 |
| Graduation Rate | 0.75 | 0.17 | 4.51 | 0.00 | 0.41 | 1.08 |
| % of Classes Under 20 | 0.03 | 0.14 | 0.21 | 0.84 | -0.25 | 0.31 |
| Student-Faculty Ratio | -1.19 | 0.39 | -3.08 | 0.00 | -1.97 | -0.41 |

The estimated multiple linear regression model is:

**Alumni Giving Rate = -20.72 + 0.75 (Graduation Rate) +0.03 (%of Classes Under 20) -1.19 (Student-Faculty Ratio)**

The R-square or coefficient of determination associated with the model is 0.70, indicating that 70% of variation in alumni giving rate is explained by the model.

The ANOVA results, *F* (3, 44) = 34.21, *p* < 0.05 indicate that the coefficient of determination is significantly different from zero. The interpretation of the constant term or the estimated y-intercept is not meaningful as it is a result of extrapolation.The model indicates that the mean alumni giving rate will increase by 0.75 percent when the graduation rate increases by 1 percent. The *p*-value for the *t* test of graduation rate (*p* value = 0.00) is less than the 0.05 level of significance implying that graduation rate has a statistically significant relationship with alumni giving rate.

The mean alumni giving rate will increase by 0.03 percent when the % of classes under 20 increases by 1 percent. However, the *p*-value linked to the *t* test for % of classes under 20 (*p* value = 0.84) is greater than the 0.05 level of significance implying that % of classes under 20 does not have a statistically significant relationship with alumni giving rate.

Further, the mean alumni giving rate will decrease by 1.19 percent when the student-faculty ration increases by one unit. The *p*-value for the *t* test of student-faculty ration (*p* value = 0.00) is less than the 0.05 level of significance implying that student-faculty ratio has a statistically significant relationship with alumni giving rate.

**4. Based on the results in parts (2) and (3), do you believe another regression model may be more appropriate? Estimate this model and discuss your results.**

Yes. Model 3 explains accounts for more variability in alumni giving rate than Model 2. In other words, addition of % of classes under 20 and student-faculty ratio improved the explained variation from 57% to 70%. However, Model 3 is not effective because one of the independent variables (% of Classes under 20) is not significant. It is therefore worth considering a model that includes only the significant independent variables, that is, graduation rate and student-faculty ratio.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SUMMARY OUTPUT | |  |  |  |  |  |
|  |  |  |  |  |  |  |
| *Regression Statistics* | |  |  |  |  |  |
| Multiple R | 0.84 |  |  |  |  |  |
| R Square | 0.70 |  |  |  |  |  |
| Adjusted R Square | 0.69 |  |  |  |  |  |
| Standard Error | 7.53 |  |  |  |  |  |
| Observations | 48 |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
|  | *df* | *SS* | *MS* | *F* | *Significance F* |  |
| Regression | 2 | 5941.02 | 2970.51 | 52.41 | 0.00 |  |
| Residual | 45 | 2550.46 | 56.68 |  |  |  |
| Total | 47 | 8491.48 |  |  |  |  |
|  |  |  |  |  |  |  |
|  | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* |
| Intercept | -19.11 | 15.55 | -1.23 | 0.23 | -50.43 | 12.21 |
| Graduation Rate | 0.76 | 0.16 | 4.72 | 0.00 | 0.43 | 1.08 |
| Student-Faculty Ratio | -1.25 | 0.28 | -4.38 | 0.00 | -1.82 | -0.67 |

The estimated multiple linear regression model is:

**Alumni Giving Rate = -19.11 + 0.76 (Graduation Rate) -1.25 (Student-Faculty Ratio)**

The R-square or coefficient of determination associated with the model is 0.70, indicating that 70% of variation in alumni giving rate is explained by the model. The ANOVA results, *F* (2, 45) = 52.41, *p* < 0.05 indicate that the coefficient of determination is significantly different from zero.

The interpretation of the constant term or the estimated y-intercept is not meaningful as it is a result of extrapolation. The estimated regression model indicates that the mean alumni giving rate will increase by 0.76 percent when the graduation rate increases by 1 percent. The *p*-value for the *t* test of graduation rate (*p* value = 0.00) is less than the 0.05 level of significance implying that graduation rate has a statistically significant relationship with alumni giving rate. In addition, the mean alumni giving rate will decrease by 1.25 percent when the student-faculty ration increases by one unit. The *p*-value for the *t* test of student-faculty ration (*p* value = 0.00) is less than the 0.05 level of significance implying that student-faculty ratio has a statistically significant relationship with alumni giving rate.

**5.What conclusions and recommendations can you derive from your analysis. What universities are achieving substantially higher alumni giving rate than would be expected, given their Graduation Rate, % of Classes Under 20, and Student/Faculty Ratio? What other independent variables could be included in the model?**

The results show that universities with high graduation rates and low student-ratio will achieve higher alumni giving rate. The % of Classes Under 20 is not a significant predictor alumni giving rate. In light of these findings, it is important for the universities to up their efforts in preparing students. A university with a greater number of well-prepared students will, on average, graduate a higher number of students. Alumni giving rates may increase as graduation rates increase. In addition, it is important for the universities to lower the student-faculty ratio by employing more faculty members. Other factors that might influence alumni giving rate include income level of the alumni and alumni’s satisfaction with the experience at the university.

**Chapter 8#1 (5)**

**5a: Construct a time series plot. What type of pattern exists in the data?**

The data exhibits a horizontal pattern. The data points appear to fluctuate around a constant average.

**5b: Develop a three-week moving average for this time series. Compute MSE and a forecast for week 7.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Week** | **Value** | **3 MA** | **Error** | **MAD** | **MSE** |
| 1 | 18 |  |  |  |  |
| 2 | 13 | #N/A |  |  |  |
| 3 | 16 | #N/A |  |  |  |
| 4 | 11 | 15.67 | -7 | 7 | 49 |
| 5 | 17 | 13.33 | -12 | 12 | 144 |
| 6 | 14 | 14.67 | -8 | 8 | 64 |
| 7 |  | **14** | **Total** | **27** | **257** |
|  |  |  |  | **6.75** | **64.25** |

The MSE is 64.25.

The forecast for week 7 is 14.

**5c: Use ⍺= 0.2 to compute the exponential smoothing values for the time series. Compute MSE and a forecast for week 7.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Value** | **Forecast** | **Error** | **MSE** |
| 1 | 18 |  |  |  |
| 2 | 13 | 3.60 | 9.40 | 88.36 |
| 3 | 16 | 5.48 | 10.52 | 110.67 |
| 4 | 11 | 7.58 | 3.42 | 11.67 |
| 5 | 17 | 8.27 | 8.73 | 76.26 |
| 6 | 14 | 10.01 | 3.99 | 15.89 |
| 7 |  | **10.81** | **Total** | **302.85** |
|  |  |  |  | **60.57** |

Actual value= At

Forecast value= Ft

Ft+1= **⍺** At + (1-**⍺**) Ft

The MSE is 60.57.

The forecast for week 7 is 10.81.

**5d: Compare the three-week moving average forecast with the exponential smoothing forecast using ⍺= 0.2. Which appears to provide the better forecast based on MSE? Explain.**

The MSE for exponential smoothing forecast is lower than that of the three-week moving average forecast. Therefore, the exponential smoothing appears to provide more accurate forecasts than the three-week moving average. The MSE measures how close the forecast is to the actual data. The lower the MSE, the more accurate the forecast.

**5e. Use trial and error to find a value of the exponential smoothing coefficient ⍺ that results in smaller MSE than what you calculated for ⍺= 0.2**

**Trial I: ⍺= 0.3**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Value** | **Forecast** | **Error** | **MSE** |
| 1 | 18 |  |  |  |
| 2 | 13 | 5.40 | 7.60 | 57.76 |
| 3 | 16 | 7.68 | 8.32 | 69.22 |
| 4 | 11 | 10.18 | 0.82 | 0.68 |
| 5 | 17 | 10.42 | 6.58 | 43.25 |
| 6 | 14 | 12.40 | 1.60 | 2.57 |
| 7 |  | 12.88 | **Total** | **173.49** |
|  |  |  |  | **34.70** |

For ⍺= 0.3, the MSE is 34.7.

**Trial II: ⍺= 0.4**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Value** | **Forecast** | **Error** | **MSE** |
| 1 | 18 |  |  |  |
| 2 | 13 | 7.20 | 5.80 | 33.64 |
| 3 | 16 | 9.52 | 6.48 | 41.99 |
| 4 | 11 | 12.11 | -1.11 | 1.24 |
| 5 | 17 | 11.67 | 5.33 | 28.44 |
| 6 | 14 | 13.80 | 0.20 | 0.04 |
| 7 |  | 13.88 | **Total** | **105.35** |
|  |  |  |  | **21.07** |

For ⍺= 0.4, the MSE is 21.7.

**Trial III: ⍺= 0.5**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Value** | **Forecast** | **Error** | **MSE** |
| 1 | 18 |  |  |  |
| 2 | 13 | 9.00 | 4.00 | 16.00 |
| 3 | 16 | 11.00 | 5.00 | 25.00 |
| 4 | 11 | 13.50 | -2.50 | 6.25 |
| 5 | 17 | 12.25 | 4.75 | 22.56 |
| 6 | 14 | 14.63 | -0.63 | 0.39 |
| 7 |  | 14.31 | **Total** | **70.20** |
|  |  |  |  | **14.04** |

For ⍺= 0.5, the MSE is 14.04.

**Trial IV: ⍺= 0.6**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Value** | **Forecast** | **Error** | **MSE** |
| 1 | 18 |  |  |  |
| 2 | 13 | 10.80 | 2.20 | 4.84 |
| 3 | 16 | 12.12 | 3.88 | 15.05 |
| 4 | 11 | 14.45 | -3.45 | 11.89 |
| 5 | 17 | 12.38 | 4.62 | 21.35 |
| 6 | 14 | 15.15 | -1.15 | 1.33 |
| 7 |  | 14.46 | **Total** | **54.46** |
|  |  |  |  | **10.89** |

For ⍺= 0.7, the MSE is 10.89.

**Trial IV: ⍺= 0.7**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Value** | **Forecast** | **Error** | **MSE** |
| 1 | 18 |  |  |  |
| 2 | 13 | 12.60 | 0.40 | 0.16 |
| 3 | 16 | 12.88 | 3.12 | 9.73 |
| 4 | 11 | 15.06 | -4.06 | 16.52 |
| 5 | 17 | 12.22 | 4.78 | 22.86 |
| 6 | 14 | 15.57 | -1.57 | 2.45 |
| 7 |  | 14.47 | **Total** | **51.72** |
|  |  |  |  | **10.34** |

For ⍺= 0.5, the MSE is 10.34.

**Trial IV: ⍺= 0.8**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week** | **Value** | **Forecast** | **Error** | **MSE** |
| 1 | 18 |  |  |  |
| 2 | 13 | 14.40 | -1.40 | 1.96 |
| 3 | 16 | 13.28 | 2.72 | 7.40 |
| 4 | 11 | 15.46 | -4.46 | 19.86 |
| 5 | 17 | 11.89 | 5.11 | 26.10 |
| 6 | 14 | 15.98 | -1.98 | 3.91 |
| 7 |  | 14.40 | **Total** | **59.23** |
|  |  |  |  | **11.85** |

For ⍺= 0.5, the MSE is 11.85.

Based on the above results, ⍺= 0.7 produces the least MSE.

**Chapter 10 #1**

**1a: Build an influence diagram that illustrates how to calculate profit**

**1b: Using mathematical notation similar to that used for Nowlin Plastics, give a mathematical model for calculating profit.**

Let: *q* = quantity required; *FC*= fixed cost; *MC*= material cost per unit; *LC*= Labor cost per unit; *TC* = Total cost to produce *q* units; *VC=*Per-unit variable cost (MC *+LC*)

The cost-volume model for producing *q* electronic components can be written as follows:

*TC (q)*= *FC* + q (*VC*)

If *FC=* $10,000; *MC=*$0.15; *LC*= $0.10; *VC=*0.15 + 0.10 = 0.25

*TC(q)*= $10,000 + $0.25*q*

Let *R* = Revenue per unit and *TR(q)*= Total revenue from selling *q* units

*TR(q)* = *Rq*

For the electronic components, *R* =$ 0.65 hence:

*TR (q)* = $0.65*q*

Let *P* (*q)* = profit from *q* units. It will therefore follow that:

*P* (*q*)= *TR (q)* – *TC (q)*

*= $ 0.65q – $ 10,000-$0.25q*

*=$0.40 - $ 10,000*

*P (q)* = $0.40 -$10,000

**Chapter 11 #1**

**1a: What is the linear programming model for this problem**

Let: R= Number of regular models produced and S= Number of Catcher’s models produced.

Total profit contribution = 5R + 8S

Because the goal is to maximize the total profit contribution the objective can be written as follows: Max 5R + 8S

Constraint 1:

The total hours used in cutting and sewing should be less than the number of hours of cutting and sewing available.

Total hours of cutting and sewing time used = R +1.5S

Only 900 hours are available for cutting and sewing, thus:

R +1.5S ≤ 900

Constraint 2:

The total hours used in finishing should be less than the number of hours of finishing available.

Total hours of finishing used = 0.5R +S

Only 300 hours are available for finishing, therefore;

0.5R +S ≤ 300

Constraint 3:

The total hours used in packaging and shipping should be less than the number of hours of packaging and shipping available.

Total hours of finishing used = R +S

Only 100 hours are available for packaging and shipping, thus:

R +S≤ 100

The linear programming model is:

Max 5R + 8S

Subject to

R +1.5S ≤ 900 Cutting and sewing

0.5R +S ≤ 300 Finishing

R +S≤ 100 Packaging and shipping

R, S ≥ 0

**1b: Develop a spreadsheet model and find the optimal solution using Excel Solver. How many of each model should Kelson Manufacture?**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Result: Solver found a solution. All constraints and optimality conditions are satisfied.** | | | | | |  |  |
| **Solver Engine** | | |  |  |  |  |  |
|  | Engine: Simplex LP | |  |  |  |  |  |
|  | Solution Time: 0.212856 Seconds. | |  |  |  |  |  |
|  | Iterations: 2 Subproblems: 0 | |  |  |  |  |  |
| **Solver Options** | | |  |  |  |  |  |
|  | Max Time Unlimited, Iterations Unlimited, Precision 1E-06, Use Automatic Scaling | | | | |  |  |
|  | Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative | | | | | | |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Objective Cell (Max) | | |  |  |  |  |  |
|  | **Cell** | **Name** | **Original Value** | **Final Value** |  |  |  |
|  | $B$15 | Total Profit Regular | 13 | 3700 |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Variable Cells | | |  |  |  |  |  |
|  | **Cell** | **Name** | **Original Value** | **Final Value** | **Integer** |  |  |
|  | $B$13 | Gloves Produced Regular | 1 | 500 | Contin |  |  |
|  | $C$13 | Gloves Produced Catcher | 1 | 150 | Contin |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Constraints | | |  |  |  |  |  |
|  | **Cell** | **Name** | **Cell Value** | **Formula** | **Status** | **Slack** |  |
|  | $B$18 | Cuting and Sewing Hours Used | 725 | $B$18<=$C$18 | Not Binding | 175 |  |
|  | $B$19 | Finishing Hours Used | 300 | $B$19<=$C$19 | Binding | 0 |  |
|  | $B$20 | Packaging and shipping Hours Used | 100 | $B$20<=$C$20 | Binding | 0 |  |

The optimal solution is for Kelson to make 500 Regular models and 150 Catcher models.

**1c. What is the total profit contribution Kelson can earn with the optimal production quantities?**

The total profit contribution Kelson can earn with the optimal solution is $3700.

**1d. How many hours of production will be scheduled in each department.**

The hours will be schedule as follows:

Cutting and sewing department = 725 hours

Finishing department = 300 hours

Packaging and shipping department = 100 hours.

**1e. What is the slack time in each department?**

The slack time for each department is as follows:

Cutting and sewing department = 175 hours

Finishing department = 0 hours

Packaging and shipping department = 0 hours.

**Chapter 12 #2**

**2a: Formulate a linear programming model that can be used to determine how the restaurant should allocate its advertising budget in order to maximize the value of total audience exposure.**

Let R= Budget spent on radio ads and N= Budget spent on newspaper ads. Therefore, the total audience exposure is given as follows:

80R + 50N

Because the goal is to maximize the value of total audience exposure the objective can be written as follows: Max 80R + 50N

Constraint 1: The budget limit for advertisement is $1000

R + N ≤ 1000

Constraint 2: Amount spent on newspaper advertising is at least twice that spent on radio ads

N ≥ 2R or 2R-N ≤ 0

Constraint 3: Total amount spent on newspaper ads should be at least 25% of the budget.

N ≥0.25 (R+N)

N≥0.25 R +0.25N

0.75N ≥ 0.25R

3N ≥ R

R-3N ≤ 0

Constraint 4: Total amount spent on radio ads should be at least 25% of the budget.

R≥ 0.25(R +N)

R≥0.25 R +0.25N

0.75R ≥ 0.25N

3R ≥ N

N ≤3R

N-3R≤ 0

The linear programming model is:

Max 80R + 50N

Subject to

R +N ≤ 1000 Monthly budget limit

2R-N ≤ 0 Amount spent on newspaper advertising is twice that of spent on radio

N-3R≤ 0 Amount spent on radio advertising is 25% of the total budget used

R-3N≤ 0 Amount spent on newspaper advertising is 25% of the total budget used

N, R ≥ 0

**2b: Develop a spreadsheet model and solve the problem using Excel Solver**.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Result: Solver found a solution. All constraints and optimality conditions are satisfied.** | | | | | |  |
| **Solver Engine** | | |  |  |  |  |
|  | Engine: Simplex LP | |  |  |  |  |
|  | Solution Time: 0.184068 Seconds. | |  |  |  |  |
|  | Iterations: 3 Subproblems: 0 | |  |  |  |  |
| **Solver Options** | | |  |  |  |  |
|  | Max Time Unlimited, Iterations Unlimited, Precision 0.000001, Use Automatic Scaling | | | | |  |
|  | Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 1%, Assume NonNegative | | | | | |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Objective Cell (Max) | | |  |  |  |  |
|  | **Cell** | **Name** | **Original Value** | **Final Value** |  |  |
|  | $B$15 | Total Audience Exposure Newspaper | 130 | 60000 |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Variable Cells | | |  |  |  |  |
|  | **Cell** | **Name** | **Original Value** | **Final Value** | **Integer** |  |
|  | $B$13 | Budget Used Newspaper | 1 | 666.67 | Contin |  |
|  | $C$13 | Budget Used Radio | 1 | 333.33 | Contin |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Constraints | | |  |  |  |  |
|  | **Cell** | **Name** | **Cell Value** | **Formula** | **Status** | **Slack** |
|  | $B$19 | Monthly budget Budget used | 1000 | $B$19<=$C$19 | Binding | 0 |
|  | $B$20 | Newspaper (Twice) Budget used | 5.68E-13 | $B$20<=$C$20 | Binding | 0 |
|  | $B$21 | Radio (25%) Budget used | -333.33 | $B$21<=$C$21 | Not Binding | 333.33 |
|  | $B$22 | Newspaper (25%) Budget used | -1666.67 | $B$22<=$C$22 | Not Binding | 1666.67 |

1. The total audience exposure the advertising can generate is 60000 people.
2. The monthly advertising budget should be allocated as follows:

* Newspaper = $ 666.67
* Radio = $ 333.33

1. The slack budget for each mode of advertisement is as follows:

* Newspaper = $ 1666.67
* Radio = $ 333.33

**Chapter 15 #1**

**1a: Construct a decision tree for this problem**

1

250

100

25

100

100

75

s1

s2

s3

s1

s2

s3

d1

d2

**1b: If the decision maker knows nothing about the probabilities of the three states of nature, what is the recommended decision using the optimistic, conservative and minimax regret approaches.**

The minimax regret approach as it is neither purely optimistic nor conservative. The first step is to compute the regret associated with each decision alternative. This is done by finding the difference between the payoff for the best decision alternative and the payoff for the worst decision. The regrets for the decisions are shown in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Decision Alternative** | **s**1 | **s**2 | **s**3 |
| d1 | 0 | 0 | 50 |
| d2 | 150 | 0 | 0 |

Next, the maximum regret for each decision alternative are listed. This list is shown in the table below.

|  |  |
| --- | --- |
| **Decision Alternative** | **Maximum Regret** |
| d1 | 50 |
| d2 | 150 |

Next, the minimum of the maximum regret values is selected. In this case, d1, is the recommended minimax regret decision.

**Chapter 15 #2**

**2a: What is the decision to be made, and what is the chance event for Southland’s problem?**

The decision problem is to select the plant size for the production of a new line of recreational products that will result in the largest profit given the uncertainty pertaining to the marketplace demand for the products. The marketplace demand for the new recreational products represents the chance event for Southland’s problem.

**2b: Construct a decision tree.**

1

150

200

200

50

200

500

Low

Medium

High

Low

Medium

High

Small

Large

**2c: Recommend a decision based on the use of the optimistic, conservative and minimax regret approaches.**

Under Optimistic Approach

Under this approach each decision alternative is evaluated in terms of the best pay off that can occur. Because Southland’s problem is to find plant size that brings maximum profit, the recommended decision alternative would be the one corresponding to the largest pay off. The table below shows the maximum payoff for each decision alternative.

|  |  |
| --- | --- |
| **Decision Alternative** | **Maximum Payoff** |
| Small | 200 |
| Large | 500 |

Because 500, corresponding to the large decision alternative, is the largest payoff, the decision to construct a large plant size is the recommended decision alternative using the optimistic approach.

Under Conservative Approach

For this approach, the decision alternatives are evaluated in terms of the worst payoff that can occur. The recommended decision is one that provides the best of the minimum payoffs. The table below illustrates the worst possible payoffs for each decision alternative.

|  |  |
| --- | --- |
| **Decision Alternative** | **Minimum Payoff** |
| Small | 150 |
| Large | 50 |

Since 150, corresponding to the small decision alternative, yields the best of the minimum payoffs, the decision alternative for a small plant size is recommended.

Under Minimax Approach

The first step is to find the regret associated with each decision alternative. This is accomplished by finding the difference between the payoff for the best decision alternative and the payoff for the worst decision. The regrets for the decisions are shown in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Decision Alternative** | **Low** | **Medium** | **High** |
| Small | 0 | 0 | 300 |
| Large | 100 | 0 | 0 |

The best payoff when the state of nature is low is $150 million while the least payoff is $50. The difference gives the regret of $100 million.

The best and worst payoffs when the state of nature is medium are equal, that is, $200 million. The difference gives the regret of $0.

The maximum payoff when the state of nature is low is $500 million while the least payoff is $200. The difference gives the regret of $300 million.

Next, the maximum regret for each decision alternative are listed. This list is shown in the table below.

|  |  |
| --- | --- |
| **Decision Alternative** | **Maximum Regret** |
| Small | 300 |
| Large | 100 |

Since 100, corresponding to the large decision alternative, yields the least of the maximum regrets, the decision alternative for a large plant size is recommended.