Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Regression Packet

Problems 1-7 (Linear Regression)

Problems 8-10 (Quadratic Regression)

Problem 11 (Cubic Regression)

Problems 12-17 (Exponential Regression)

Problems 18-22 (Finding the best-fit model to a given data set)

Regression Equations Packet

1. Mean Price of Apples per pound for 1980 to 2000

|  |  |  |  |
| --- | --- | --- | --- |
| 1980 | $0.593 | 1991 | $0.843 |
| 1981 | 0.525 | 1992 | 0.899 |
| 1982 | 0.648 | 1993 | 0.802 |
| 1983 | 0.532 | 1994 | 0.804 |
| 1984 | 0.64 | 1995 | 0.793 |
| 1985 | 0.677 | 1996 | 0.894 |
| 1986 | 0.72 | 1997 | 0.914 |
| 1987 | 0.741 | 1998 | 0.962 |
| 1988 | 0.635 | 1999 | 0.852 |
| 1989 | 0.742 | 2000 | 0.96 |
| 1990 | 0.652 |  |  |

1. Determine which variable is independent and which is dependent. Enter the data into the lists of your calculator.
2. Look at a scatter plot of the data. Describe the scatter plot.
3. Use LinReg to determine the regression line that fits this data. Write the equation in the function list.
4. Superimpose the line over the data. Do you think this model is a good fit for the data?
5. What is the meaning of the y-intercept and the slope of the line?
6. Using your line of best-fit, predict the price per pound of apples in 2010.
7. Wave Data

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Number of students | 6 | 7 | 11 | 12 | 14 | 16 | 17 | 20 | 22 | 26 |
| Time (seconds) | 2.07 | 3.03 | 2.09 | 3.40 | 3.51 | 4.53 | 3.94 | 4.56 | 5.38 | 6.25 |

1. Determine which variable is the independent and which is dependent. Enter the data into the lists of our calculator.
2. Look at a scatter plot of the data. What correlation do you see?
3. Use LinReg to determine the regression line that fits this data. Write the equation in the function list.
4. Superimpose the line over the data. Do you think this model fits the data?
5. Discuss the meaning of the y-intercept and the slope of the line.
6. Predict the time it will take all 550 students to the do the move.
7. The recommended maximum heart rate during exercise is found in the table below. Write a prediction (linear) equation that relates age to heart rate. Find your recommended heart rate during exercise.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Age | 20 | 26 | 30 | 38 | 45 | 52 | 60 |
| Hear beats per minute | 200 | 194 | 190 | 182 | 175 | 168 | 160 |

1. Wise parents start saving for their child’s college tuition when the child is born. These parents need an estimate of future tuition costs. Make a scatter plot for the tuition data for state colleges.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 |
| Tuition ($) | 425 | 850 | 1200 | 1625 | 2025 | 2500 |

1. Write a prediction equation (linear regression).
2. Predict the cost of tuition for the year 2010.
3. Rachel Lewis sells cars. She makes a base salary of $100 per month plus a commission of 1% of the selling price of each car. For six months Ms. Lewis has tabulated the number of cars she has sold each month and the amount of money she has made. Is there a relationship between the numbers so she can estimate her monthly salary? Use the chart to write an equation in sope-intercept form that approximates the relationship. If Ms. Lewis sells 5 cars, how much money will she make for the month?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of cars sold | 18 | 22 | 10 | 11 | 14 | 17 |
| Money Made ($) | 3544 | 4108 | 2413 | 2554 | 2978 | 3401 |

1. Susan works for the admissions office at UNC-Wilmington. She is doing some research and fins some data regarding the number of thousands of men and women who graduated from college in the years 1991-1998. Here is the data that she recorded.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| Men | 470 | 473 | 479 | 482 | 483 | 486 | 481 | 472 |
| Women | 465 | 480 | 490 | 492 | 497 | 502 | 510 | 517 |

1. Use a graphing calculator to find a linear regression equation relating the year to the number of thousands of men. Then find a regression equation for thousands of women.
2. Use the table function to predict the number of men who will graduate from college in the years 2000 and 2015.
3. Use the table function to predict the number of women who will graduate from college in the years 2000 and 2015.
4. Percent of Food Expenditures Away from Home

|  |  |  |  |
| --- | --- | --- | --- |
| 1935 | 12.9 | 1970 | 26.3 |
| 1940 | 15.2 | 1975 | 28.5 |
| 1945 | 19.6 | 1980 | 32.2 |
| 1950 | 17.8 | 1985 | 35.8 |
| 1955 | 18.6 | 1990 | 36.7 |
| 1960 | 19.9 | 1995 | 38.2 |
| 1965 | 22.8 |  |  |

1. Using your calculator, do a scatter plot of the data above. What is the Linear Regression (Best fit line) for the data? What does each variable represent?
2. What is the meaning of the slope? What is the meaning of the y-intercept?
3. Using this linear function as an equation fo prediction, find the percent of food expenditures spent away from home in the year 2010. What does this number mean? Do you think this is reasonable?

The Football and Breaking Distance: Model Data with Quadratic Functions.

1. A student standing at the top of the bleachers throws a football across the field. The data that follows give the height of the ball in feet versus the seconds since the ball was thrown.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time | 0.2 | 0.6 | 1 | 1.2 | 1.5 | 2 | 2.5 | 2.8 | 3.4 | 3.8 | 4.5 |
| Height | 92 | 110 | 130 | 134 | 142 | 144 | 140 | 132 | 112 | 90 | 44 |

1. Show a scatter plot of the data. What is the independent variable, and what is the dependent variable?
2. What prediction equation (mathematical model) descries this data? (Use quadratic regression from the calculator.)
3. When will the ball be at a height of 150 feet? Explain.
4. When will the ball be at a height of 100 feet?
5. At what times will the ball be at a height of greater than 100 feet?
6. When will the ball be at a height of 40 feet?
7. When will the ball hit the ground?
8. Braking Distance

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Speed of car (mph) | 0 | 22 | 33 | 44 | 55 |
| Reaction distance (ft) | 0 | 22 | 33 | 44 | 55 |
| Braking distance (ft) | 0 | 19 | 43 | 79 | 128 |

1. Develop a mathematical model that can be used to predict the reaction distance (y) given the speed (x).
2. Develop a mathematical model that allows us to predict breaking distance (y) given the speed of the car (x).
3. Develop a mathematical model that will predict total stopping distance (y = braking + reaction) given the speed of the car (x).
4. Usually when there is a wreck police investigators are attempting to determine the speed of the driver. To do this, the investigators measure the length of the skid marks left on the pavement. How could we us the information about the models to able to predict the speed of the driver given the length of the skid mark?
5. *Oil Recovery* In 1978, Congress conducted a study of the amount of additional oil that can be extracted from existing oil wells by “enhanced recovery techniques” (such as injecting solvents or steam into an oil well to lower the density of the oil). As the price of oil increases, the amount of oil that can be recovered economically in this manner also increases. The following table gives the study’s estimates of recoverable oil based on the price per barrel.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Price per barrel | $12 | $14 | $22 | $30 |
| Recovery (billions of barrels) | 21.2 | 29.4 | 41.6 | 49.2 |

1. Find the quadratic model that best fits this data.
2. Is it a good fit? Explain.
3. Use this equation to estimate the additional amount of oil that can be economically recovered if the price of oil were to drop to $10 per barrel.
4. Enter the following data into your calculator. Using a cubic regression model, answer the following:

|  |  |
| --- | --- |
| Speed mph (x) | Fuel Economy mpg (y) |
| 10 | 22 |
| 20 | 42 |
| 30 | 46 |
| 40 | 48 |
| 50 | 45 |
| 60 | 41 |
| 70 | 39 |
| 80 | 38 |

1. What is the cubic regression equation that you found?
2. Is it a good fit for the data? Explain.
3. Using this equation, find the fuel economy (mpg) if the speed is 65.
4. What possible speeds would a car be traveling if the fuel economy (mpg) was 40?

Write an exponential equation (model) given a set of data.

1.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | 1800 | 1850 | 1900 | 1950 | 2000 |
| U.S. Population (millions) | 5 | 23 | 76 | 151 | 281 |

1. Write an exponential model.
2. Predict U.S. population in 2005.
3. Predict when population would be 500 million.
4. Cooling coffee.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time (min) | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| Degrees F above room temperature | 135 | 100 | 74 | 55 | 41 | 30 | 22 | 17 | 12 | 9 | 7 | 5 | 4 |

1. Write an exponential model.
2. Predict degrees above room temperature after 2 minutes.
3. Predict when the temperature would be 20 degrees above room temperature.
4. In 1985, Kayla received $30.00 from her grandparents for her fifth birthday. Her mother deposited it into a bank account for her. Both Kayla and her mother forgot about the money and made n9o further deposits or withdrawals. The table below shows the account balance for several years.

|  |  |
| --- | --- |
| Elapsed Time (years) | Balance |
| 0 | $30.00 |
| 5 | $41.10 |
| 10 | $56.31 |
| 15 | $77.16 |
| 20 | $105.71 |
| 25 | $144.83 |
| 30 | $198.43 |

1. Use your calculator to find an exponential model to fit this data. Write your equation below.
2. How well does your model fit this data? Explain.
3. If Kayla discovers the account with the birthday money on her 50th birthday, how much will she have in the account?
4. The following table shows after-tax profits of South African Breweries for the years 1991 through 1997.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
| Profit ($ million) | 330 | 340 | 360 | 400 | 500 | 580 | 600 |

1. Write an exponential model that best describes this data.
2. Is it a good fit? Explain.
3. Use an exponential regression of the data to predict SAB’s profit in 2000.
4. The North Carolina population is counted with every census. In the table below, the populations are given for every other census. Using an exponential model, predict the population in 2020.

|  |  |
| --- | --- |
| Year | Population (to nearest 1000) |
| 1800 | 478,000 |
| 1820 | 639,000 |
| 1840 | 753,000 |
| 1860 | 993,000 |
| 1880 | 1,400,000 |
| 1900 | 1,894,000 |
| 1920 | 2,559,000 |
| 1940 | 3,572,000 |
| 1960 | 4,556,000 |
| 1980 | 5,880,000 |
| 2000 | 8,049,000 |

1. Got most people, the half-life of caffeine is 7 hours. Seven hours after eating some amount of caffeine, you will have one-half of that amount in your body. If you drink a cup of coffee at 7 am, the coffee introduces 5 milligrams of caffeine into your body. How much caffeine will be in your body when you go to sleep that night? (Use an exponential model for this data.) (Let’s say you go to sleep at 11:00 pm)

Best-fit Regression: Modeling Real World Data

Be sure that your diagnostics is turned on to get the $R^{2}$ value: 2nd 0 (zero) for the Catalog.

* Press the $x^{-1}$ key to scroll down to “D.” Arrow down to DiagnosticOn. Hit enter twice.

Round coefficients to 2 decimal places and $R^{2}$ to 4 decimal places.

1. Use the first-class stamp data below to answer the following questions.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Years since 1900 | 58 | 63 | 68 | 71 | 74 | 78 | 81 | 83 | 88 | 95 | 99 | 101 | 102 | 107 |
| Cost (cents) | 4 | 5 | 6 | 8 | 10 | 15 | 18 | 22 | 25 | 32 | 33 | 34 | 37 | 39 |

1. Which variable is the independent variable?
2. Which variable is the dependent variable?
3. Find a quadratic model for the data. Record the equation and $R^{2}$ value.
4. Find the cubic model for the data. Record the equation and the $R^{2}$ value.
5. Find an exponential model for the data. Record the equation and the $R^{2}$ value.
6. Which model is best? Look for the highest $R^{2}$.
7. Using the best model, Predict the cost of a first-class stamp in 2010.
8. Using the best model, predict when first-class postage will reach 50 cents.
9. The table shows the number of answering machines sold in the U.S. (Note which value is $L\_{1}$.)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Answering Machines Sold (millions) ($L\_{2}$) | 2 | 4.2 | 8.8 | 11.1 | 13.8 | 16 | 17.7 | 20 |
| Years since 1980 ($L\_{1}$) | 3 | 5 | 7 | 8 | 10 | 12 | 15 | 20 |

1. Which variable is the independent variable (x)?
2. Which variable is the dependent variable (y)?
3. Find a cubic model for the data. Record the equation and $R^{2}$ value.
4. Find an exponential model for the data. Record the equation and $R^{2}$ value.
5. Using the best model, predict the number of answering machines sold in 1997.
6. The data below detail the life expectancy for residents of the U.S.

|  |  |
| --- | --- |
|  | Life Expectancy (years) |
| Year of Birth | Males | Females |
| 1970 | 67.1 | 74.1 |
| 1980 | 70 | 77.4 |
| 1990 | 71.8 | 78.8 |
| 2000 | 73.2 | 80.2 |
| 2010 | 74.5 | 81.3 |

1. Find a cubic polynomial to model the life expectancy for males.
2. Find a cubic polynomial to model the life expectancy for females.
3. Estimate the life expectancy of a girl born in 1999.
4. Estimate your own life expectancy.
5. Estimate the life expectancy of a boy born when you are 24.
6. Use the fishing data to answer the following questions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | 1988 | 1989 | 1990 | 1992 | 1993 |
| Live Weight Catch (in thousands of metric tons) | 53446 | 54678 | 52939 | 51782 | 53569 |

1. Which variable is the independent variable (x)?
2. Which variable is the dependent variable (y)?
3. Find a cubic function to model the data above.
4. Use the function to estimate the catch in 1991.
5. The actual catch in 1991 was 52011 thousand metric tons. How did your estimate compare?
6. Use the function to estimate the catch in 1999. Do you think this estimate is reasonable?
7. Hurricane Fran hit North Carolina on the evening of September 5, 1996. Over one million homes and businesses were left without power. Repair crews began immediately restoring electrical service.

|  |  |
| --- | --- |
| Date | Customers without power |
| Sept 6 | 1,159,0100 |
| Sept 7 | 804,000 |
| Sept 8 | 515,000 |
| Sept 9 | 340,500 |
| Sept 10 | 195,200 |
| Sept 11 | 136,300 |
| Sept 12 | 77,000 |
| Sept 13 | 37,600 |

1. Based on the graph of the data, which equation (cubic, exponential, or quadratic) is most likely to generate a good algebraic model of the hurricane recovery?
2. According to the model, describe the recovery effort.
3. If the recovery continued at the same pace, how long until all power was restored (less than 1,000 customers without power)?