Exam 1 Practice Problems

1. Suppose you are going on a weekend trip to a city that is *d* miles away. Develop a model that determines your round-trip gasoline costs. What assumptions or approximations are necessary to make your model deterministic? Are these assumptions or approximations acceptable to you?
    a. Draw an influence chart and build a model for this problem.
    b. Use your model to generate some relevant sensitivity analysis.

2. Suppose we have the following mathematical model of a production system

$$\begin{aligned} \max \quad & 10x \\ \text{s.t.} \quad & ax \leq 40 \\ & x \geq 0 \end{aligned}$$

    where *a* is the number hours of production time required for each unit produced. With *a* = 5, the optimal solution is *x* = 8. If we have a stochastic model with *a* = 3, *a* = 4, *a* = 5, and *a* = 6 as the possible values for the number of hours required per unit, what is the optimal value for *x*? What challenges does this stochastic model cause?

3. Brady Duncan is a co-owner of Mad Tree Brewing Company (MTB) which produces the very popular Bearcat Ale. Brady would like to develop a spreadsheet model to help him determine the best sales price for Bearcat Ale which he currently sells for $30.00 per gallon. Brady has done extensive market research to estimate the price-demand curve for Bearcat Ale. He has estimated that at a sales price of $25.00 per gallon, Mad Tree could sell 8,000 gallons of Bearcat Ale per week and that a $0.01 increase/decrease in price would decrease/increase sales by 5 gallons per week. However, MTB can only produce 5,000 gallons of ale per week with a production cost of $15.00 per gallon. The primary ingredients of Bearcat Ale are barley and hops. Each gallon of Bearcat Ale requires 1.25 pounds of barley which costs $5.00 per pound. Each gallon also requires 0.30 pounds of hops which costs $8.25 per pound. The fixed cost of operating the brewery is $4,000 per week.

    a. Construct an influence chart for this problem using the drawing objects in the InfluenceChartTemplate.xlsx file.
    b. Construct a well-designed spreadsheet model to compute the total profit for MTB. Your spreadsheet model should follow the best practices that have been covered in this course.
    c. How does MTB's profit vary with the sales price of Bearcat Ale from $20 to $40? Include an appropriate table and chart and a verbal description of this relationship. What sales price would you recommend that MTB use and why?

4. Over a five year period, the quarterly change in the share price for a company ranged from -8% to 12%. The current share price is $80.00, and we would like to understand the distribution of this share price in two years (eight quarters).
    a. Using a sample size of 10,000 trials, generate a histogram of the share price at the end of two years.
    b. Estimate the expected share price at the end of 2 years and compute a 90% confidence interval for this estimate.
    c. Estimate the probability the share value at the end of 2 years is at least $100 and compute a 95% confidence interval for this probability estimate.

5. A company is considering the introduction of a new product. The fixed cost to launch this product is $30,000. The variable cost for the product is uniformly distributed between $16 and $24 per unit. The product will sell for $50 per unit. The demand for the product is normally distributed with a mean of 1,200 units and a standard deviation of 300 units. Construct a simulation model for this problem and use a sample size of 10,000 trials to answer the following questions.
    a. What is the distribution of the outcome from this new product launch?
    b. What is your assessment of the associated risk?

6. A real estate investment firm purchases, develops, and then resells property for a profit. A new property is available which the firm believes could be resold at a price of $160,000. The current property owner has requested bids from the firm and two other competitors and will sell the property to the highest bidder in excess of $100,000. Assume that the bids made by each of the two competitors will be uniformly distributed from $100,000 to $150,000. Construct a simulation model for this problem and use a sample size of 10,000 trials to answer the following questions.
    a. What is the probability the firm will win the bidding process if it offers $130,000 for the new property? Provide a 95% confidence interval for your estimate.
    b. What is the bid amount the firm should offer to achieve at least a 90% probability of winning the bid?
    c. What is the bid amount the firm should offer to maximize its expected profit?
    d. What is the expected value of perfect information for this problem?

7. A wedding planner must give the caterer an estimated number of guests for a wedding reception. The probability that a guest responds to the RSVP invitation for the wedding is 30%. A guest who responds has a 90% probability of actually attending the reception. A guest who does not respond to the invitation has a 50% probability of attending the reception.
    a. If 300 guests were invited, what is the probability that at least 200 attend the reception?

b. How many guests would you suggest the wedding planner estimate for the caterer and why?

Answers to Selected Problems:

1. Answers depend on a number of different assumptions.

2. If *a* is known the optimal values of *x* are 13.333, 10, 8, and 6.667. Because *a* is stochastic (random/uncertain), then *x* = 6.667 is the optimal value that always satisfies the constraint.

3. (b) Base case profit = $27,375 per week
   (c) Recommended sales price = $32 per gallon generates profit = $33,238

4. (b) Sample mean = $93.88; 90% CI = (93.63, 94.13)
   (c) sample proportion = 32.74%; 95% CI = (32.31, 33.17)

5. Mean profit should be around $6,000;
   probability of a loss should be around 27%.

6. Around 36% chance of winning the bid;
   recommended bid is around $140,000.

7. (a) sample proportion = 4.20%; sample mean = 186.0
   (b) answers may vary: the probability of exceeding 205 guests is less than 1%; the probability of exceeding 220 guests is virtually zero.