Lecture 2

1. A computer company produces laptop and desktop computers. The Marketing Department projects that the expected demand for laptops will be at least 1,000, and for desktops it will be at least 800 per day. The production facility has a limited capacity of no more than 2,000 laptops and 1,700 desktops per day. The Sales Department indicates that contractual agreements of at most 2,000 computers per day must be satisfied. Each laptop computer generates $600 net profit and each desktop computer generates $300 net profit. The company wants to determine how many of each type should be made daily to maximize net profits. Formulate a linear programming model that represents the preceding business description.
   a. Solve the problems graphically and indicate:
   • What is the optimal number of laptop and desktop computers to be made each day?
   • What is the value of the objective function (total net profit) for the solution?
   • Identify binding and not binding constraints for the optimal solution.
   b. Solve the same problem using Excel's Solver.

2. You run an animal shelter facility and are asked to purchase food supply for the next month. You normally purchase two types of food, Purina and Natural Choice. Purina costs $180 per bag. Each bag weighs 40 kilograms and can feed as many as six animals per month. The Natural Choice bag costs $110, weighs 60 kilograms, and can feed four animals per month. You have been given a maximum budget of $4,000 for this purchase, although you don't have to spend that much. The facility has room for no more than 1,000

kilograms and boards an average of 100 animals per day during a typical month. How many bags of each type of food should you buy to minimize the purchasing cost?

a. Formulate and solve the problems graphically to determine:

• What is the optimal number of Purina and Natural Choice bags to be purchased each month?

• What is the value of the objective function (total purchasing cost) for the preceding solution?

• Identify binding and not binding constraints for the optimal solution.

b. Solve the same problem using Solver and compare the Solver solution to the graphical solution.

3. Linear programming is considered to be one of the most commonly used techniques for prescriptive analytics in business organizations.
   a. True
   b. False

4. Linear programming is a mathematical programming approach in which at least the objective function or the constraints are assumed to be linear.
   a. True
   b. False

5. The proportionality feature of linear programming models assumes that the contribution of decision variables to the objective function is proportional to their values.
    a. True
    b. False

6. The proportionality feature of linear programming models assumes that the contribution of decision variables to each resource constraint is proportional to their values.
    a. True
    b. False

7. The additivity feature of linear programming models assumes that the objective function can be calculated by adding the individual contributions of each decision variable.
    a. True
    b. False

8. The additivity feature of linear programming models assumes that the usage of each constraint can be calculated by adding the individual usage of the constraint by each decision variable.
    a. True
    b. False

9. The optimal solution of a linear programming model occurs at a corner of the feasible region.

a. True

b. False

10. In the case of maximization problems, the line representing the objective function is moved upward and parallel to itself until reaching the first point of contact with the area of feasible solution.

    a. True

    b. False

11. In the case of minimization problems, the line representing the objective function is moved upward and parallel to itself until reaching the first point of contact with the area of feasible solution.

    a. True

    b. False

12. Binding constraints are represented by lines that intersect at the point of the optimal solution.

    a. True

    b. False

13. Resources represented by binding constraints are fully used by the optimal solution.

    a. True

    b. False

14. Linear programming models have multiple solutions when the slope of the iso-profit line of the objective function differs from the slopes of each line representing any binding constraint.
    a. True
    b. False

15. If the iso-profit line has the same slope as the line of a binding constraint, then the model has an infinite number of solutions.
    a. True
    b. False

16. Linear programming models with infeasible solutions often arise in practice because management expectations are too high.
    a. True
    b. False

17. Solver is a Microsoft Excel add-in used to successfully solve linear programming models only.
    a. True
    b. False

18. Following a step-by-step approach to formulate and solve linear programming models helps practitioners to avoid complexity.
    a. True
    b. False

19. Which of the following make linear programming (LP) a popular tool for data scientists?
    a. LP structure allows practitioners to achieve goals despite limited resources.
    b. LP models are easy to formulate.
    c. LP models are easy to solve.
    d. All of the above

20. Which of the following is not a concept related to linearity?
    a. Proportionality
    b. Additivity
    c. Feasibility
    d. All of the above concepts are related to linearity.

21. The proportionality feature of linear programming (LP) models assumes all of the following except that:
    a. The contribution of decision variables to the objective function is proportional.
    b. The contribution of decision variables to each resource is proportional.
    c. The contribution of each decision variable can be added to obtain the overall value of the objective function.
    d. All of the above are features of proportionality in LP.

22. Which of the following is assumed when considering the additivity feature of linear programming (LP) models?
    a. The contribution of decision variables to the objective function is proportional.
    b. The contribution of decision variables to each resource is proportional.
    c. The contribution of each decision variable can be added to obtain the overall value of the objective function.
    d. All of the above are features of proportionality in LP.

23. The additivity feature of linear programming (LP) models assumes all of the following except that:
    a. The contribution of decision variables to the objective function is proportional.
    b. The contribution of each decision variable can be added to obtain the overall usage of a given constraint.
    c. The contribution of each decision variable can be added to obtain the overall value of the objective function.
    d. All of the above are features of proportionality in LP.

24. Which of the following is assumed when considering the linearity feature of linear programming (LP) models?
    a. The contribution of decision variables to the objective function is proportional.
    b. The contribution of each decision variable can be added to obtain the overall usage of a given constraint.

c. The contribution of each decision variable can be added to obtain the overall value of the objective function.

d. All of the above are features of proportionality in LP.

25. Why it is important for a modeler to follow a step-by-step methodology when formulating linear programming models?

a. The modeler can avoid the complexity of the models.

b. The modeler can implement a “model less, iterate more” approach to improve the efficiency of the optimization algorithms.

c. The modeler can use the formulated model multiple times with newly calculated input parameters.

d. The modeler can fine-tune the model accordingly.

26. Which of the following is not a major step when formulating linear programming models?

a. Defining decision variables

b. Defining the value of decision variables

c. Formulating the objective function

d. Identifying the set of constraints

e. Identifying the set of non-negativity constraints

27. Which of the following is the most important reason for defining decision variables as part of linear programming (LP) formulation?

a. The decision variables will set the stage for the rest of the formulation steps.
b. The value of the decision variables will determine how many units will be produced at any given time.
c. The value of the decision variables will determine how many constraints are needed in the LP model.
d. The decision variables also determine how many goals the decision maker must achieve.

28. Which of the following is not a suggested step when formulating an objective function?
    a. Identifying a set of non-negativity constraints
    b. Defining whether the goal is to maximize or minimize the objective function
    c. Identifying contribution coefficients
    d. Creating the equation for the objective function

29. A maximization objective function could be used by the modeler in any of the following situations except:
    a. When trying to optimize profit.
    b. When trying to reach production levels.
    c. When trying to improve customer satisfaction.
    d. When trying to optimize cost.

30. A minimization objective function could be used by the modeler in any of the following situations except:

a. When trying to optimize profit.

b. When trying to minimize production waste.

c. When trying to improve processing times.

d. When trying to optimize cost.

31. Which of the following is not a major step when establishing constraints in a linear programming model?

a. Identifying the right-hand-side values for each resource

b. Calculating the left-hand-side value

c. Placing ≤ , = , or ≥ between the left- and right-hand-side values for each constraint

d. Identifying non-negativity constraints

32. Which of the following is a situation in which ≤ (i.e., the less-than-or equal-to sign) must be used?

a. When a constraint represents the usage of available labor hours

b. When a constraint indicates that the manager wants to produce at least the ordered amount for a certain product

c. When a constraint indicates that the manager should not exceed the machine hours available

d. All of the above

33. Which of the following situations is associated with a non-binding constraint in the solution of the linear programming model?

a. A non-binding constraint always has no slack (slack = 0).

b. A non-binding constraint always has slack (slack > 0).

c. A non-binding constraint sometimes has negative slack (slack < 0).

d. None of the above

34. If funding is available to purchase additional resources, then a decision maker must recommend that the company invest in resources represented by:

a. A binding constraint.

b. A non-binding constraint.

c. A non-negativity constraint.

d. None of the above

35. Which of the following describes a situation in which linear programming models result in infeasible solutions?

a. The model has many restrictions, and the constraints do not have a common feasible region.

b. The model has unrealistic goals, and the objective function cannot be maximized.

c. The model has unrealistic goals, and the objective function cannot be minimized.

d. All of the above

36. The graphical approach to solving linear programming models:

a. Provides a visual and intuitive understanding of these models.

b. Provides a visual and intuitive understanding of the solution process.

c. Provides a visual demonstration the feasibility area.

d. Provides a visual understanding of the objective function.

e. All of the above are advantages of using the graphical approach.

37. Which of the following steps can be used to solve a linear programming (LP) model graphically?

a. Graph the area of feasible solutions

b. Graph the objective function

c. Identify the coordinates for the optimal point

d. Identify the value of the objective function at the optimal solution

e. All of the above