

UNIVERSITY OF BOLTON
INSTITUTE OF MANAGEMENT
BA (HONS) ACCOUNTANCY
SEMESTER ONE EXAMINATIONS 2022/2023
QUANTITATIVE METHODS FOR ACCOUNTANTS
MODULE NO: ACC4018

Date: Wednesday 11 January 2023

Time: 10.00 – 1.00

INSTRUCTIONS TO CANDIDATES:

There are four compulsory questions on this paper.

Answer **all four** questions.

All questions carry equal marks.

Calculators may be used but full workings must be shown.

Formulae books, which contain statistical tables.

Graph paper (four sheets).

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Question 1

A farmer produces two products: X and Y. The farmer employs 150 skilled workers and 100 unskilled workers, and works 40 hours a week. Production of each product X takes 5 skilled hours and 2 unskilled hours. Whereas, production of product Y takes 4 skilled hours and 6 unskilled hours.

The contribution to profit that can be obtained is £15 per unit from X, and £25 per unit from Y.

- a) Arrange the given information into tabular form. **(5 Marks)**
- b) Translate the problem into a linear programming one, identifying and writing down the objective function and the constraints. **(3 marks)**
- c) Use the algebraic method to calculate how many units of product X and Y would be produced to maximise profitability. **(7 marks)**
- d) Plot the inequalities on a graph and identify the feasible region. **(10 marks)**

(Total 25 marks)

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Question 2

A high school boy takes part in a long jump competition. He takes three attempts at jumping and scoring the highest score.

The probabilities are as follows:

They have a 0.70 probability of successfully scoring the highest score at their first attempt.

If they succeed at the first attempt, the same probability applies on the next two attempts.

If they are not successful at any time, the probability of succeeding on any subsequent attempts is only 0.2.

Use a tree diagram to find the probabilities that:

- a) Draw a tree diagram to show the probabilities of success or failure. **(5 marks)**
- b) She is successful on all her first three attempts. **(5 marks)**
- c) She fails at the first attempt but succeeds on the next two. **(5 marks)**
- d) She is successful just once in three attempts **(5 marks)**
- e) She is still not successful after the third attempt **(5 marks)**

(Total 25 marks)

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Question 3

The Table below shows a sample of distances that 40 students travelled (Km).

| | | | | | | | |
|----|----|----|----|----|----|----|----|
| 25 | 51 | 36 | 60 | 19 | 58 | 46 | 30 |
| 34 | 27 | 52 | 33 | 61 | 30 | 51 | 43 |
| 56 | 39 | 20 | 54 | 44 | 48 | 24 | 25 |
| 17 | 64 | 43 | 50 | 38 | 38 | 40 | 50 |
| 30 | 38 | 54 | 37 | 42 | 36 | 59 | 33 |

- a) Produce a grouped frequency distribution (GFD) table for this data. **(5 marks)**
- b) Draw a histogram of the grouped frequency distribution, and on the same graph estimate the mode of travel. **(5 marks)**
- c) From the GFD calculate the mean deviation. **(5 marks)**
- d) From the GFD calculate the mean distance travelled. **(5 marks)**
- e) Calculate the corresponding variance and standard deviation. **(5 marks)**

(Total 25 marks)

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Question 4

A marketing team wants to determine the relationship between the cost of advertising and sales.

The monthly sales are thought to depend on the advertising.

The table below shows a record for a random sample over 10 months.
 Data shows:

| Month | Sales (£'000) | Advertising cost (£'000) |
|-------|---------------|--------------------------|
| 1 | 8 | 10 |
| 2 | 12 | 14 |
| 3 | 4 | 8 |
| 4 | 16 | 18 |
| 5 | 12 | 14 |
| 6 | 20 | 28 |
| 7 | 10 | 12 |
| 8 | 4 | 8 |
| 9 | 8 | 10 |
| 10 | 12 | 14 |

Required:

Please show all calculation workings.

- a) Draw a scatter diagram of these results.

(5 Marks)

- b) Calculate the equation of the least square regression line of "y on x" and then draw this line on the scatter diagram.

(10 Marks)

- c) Calculate the Pearson's correlation coefficient, r and the coefficient of determination r^2 .

(6 Marks)

- d) Use the regression equation/line to predict the likely cost of 2 months if output is 4, and 16 respectively.

(4 marks)

(Total 25 marks)

END OF QUESTIONS

STATISTICAL FORMULAE

FREQUENCY DISTRIBUTIONS

Required fractile from a GFD = Lower class limit of fractile class +

$$\left[\frac{\text{Fractile item} - \text{cumulative frequency up to lower class limit of fractile class}}{\text{Fractile class frequency}} \times \text{class interval} \right]$$

$$\text{Mean } \bar{x} = \frac{\text{sum of values}}{\text{total number of items}} = \frac{\sum x}{n}$$

$$\text{with GFD: } \bar{x} = \frac{\sum(f \times \text{MP})}{\sum f} \quad \text{MP} = \text{class Mid Point}$$

Range = Highest value – Lowest value

Quartile deviation = $(Q_3 - Q_1)/2$

$$\text{Mean deviation} = \frac{\sum(x - \bar{x})}{n} \quad \text{The sign of } (x - \bar{x}) \text{ must be ignored}$$

$$\text{with GFD: M.D.} = \frac{\sum(f \times (\text{MP} - \bar{x}))}{\sum f}$$

$$\text{Standard deviation (s)} = \sqrt{\frac{\sum(x - \bar{x})^2}{n}}$$

$$\text{If the mean is not a rounded number: } s = \sqrt{\frac{\sum x^2}{n} - \bar{x}^2}$$

$$\text{with GFD: } s = \sqrt{\frac{\sum(f \times \text{MP}^2)}{\sum f} - \bar{x}^2}$$

Variance: s^2

$$\text{Coefficient of variation} = \frac{s}{\bar{x}} \times 100$$

$$\text{Pearson's Coefficient of Skewness (Sk)} = \frac{3 (\text{Mean} - \text{Median})}{\text{Standard Deviation}}$$

CORRELATION

Regression line of "y on x": $y = a + bx$

where $b = \frac{n \times \sum xy - \sum x \times \sum y}{n \times \sum x^2 - (\sum x)^2}$ $a = \frac{\sum y - b \times \sum x}{n}$ $n = \text{number of pairs}$

Regression line of "x on y": $x = a + by$

where $b = \frac{n \times \sum yx - \sum y \times \sum x}{n \times \sum y^2 - (\sum y)^2}$ $a = \frac{\sum x - b \times \sum y}{n}$

Pearson product-moment Coefficient of Correlation (r)

$$r = \frac{n \times \sum xy - \sum x \times \sum y}{\sqrt{((n \times \sum x^2 - (\sum x)^2) (n \times \sum y^2 - (\sum y)^2))}}$$

Coefficient of determination $r^2 = b_{yx} \times b_{xy} \Rightarrow r = \sqrt{b_{yx} \times b_{xy}}$

Covariance: $\text{Cov}(x,y) = \frac{\sum(x - \bar{x})(y - \bar{y})}{n} \Rightarrow r = \frac{\text{Cov}(x,y)}{(S_x \times S_y)}$

Spearman's Coefficient of Rank Correlation: $r^2 = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$

where $d = \text{the difference between the rankings of the same item in each series}$

PROBABILITY

Multiplication rule: the prob. of a *sequential* event is the product of all its elementary events

$$P(A \cap B \cap C \cap \dots) = P(A) \times P(B) \times P(C) \dots$$

Addition rule: the prob. of one of a number of *mutually exclusive* events occurring is the sum of the probabilities of the events

$$P(X \cup Y \cup Z \cup \dots) = P(X) + P(Y) + P(Z) \dots$$

Bayes' Theorem $P(E | S) = \frac{P(E) \times P(S | E)}{\sum_i (P(E_i) \times P(S | E_i))}$

where S is the subsequent event and there are n prior events, E .

PROBABILITY DISTRIBUTIONS

Binomial distribution $P(x) = \binom{n}{x} p^x q^{n-x}$ where p = constant probability of a success
 $q = 1 - p$ = probability of a failure
 Mean = np
 Standard deviation = \sqrt{npq}

Poisson distribution $P(x) = e^{-a} \frac{a^x}{x!}$ where $e \cong 2.718$ is a constant
 Mean = $a = np$
 Standard deviation = \sqrt{a}

Simplified Poisson $P(x + 1) = P(x) \times \frac{a}{x + 1}$

Normal distribution: standardised value $z = \frac{x - \mu}{\sigma}$

where μ and σ are the mean and standard deviation of the actual distribution

ESTIMATION & CONFIDENCE INTERVALS

- \bar{x} , s , p – sample mean, standard deviation, proportion/percentage
 - μ , σ , π – population mean, standard deviation, proportion/percentage
- ⇒ \bar{x} is a point estimate of μ
 s is a point estimate of σ
 p is a point estimate of π

Confidence intervals for a population percentage or proportion

$$\pi = p \pm z \sqrt{\frac{p(100-p)}{n}} \quad \text{for a percentage} \qquad \pi = p \pm z \sqrt{\frac{p(1-p)}{n}} \quad \text{for a proportion}$$

When using normal tables: $\alpha = 100 - \text{confidence level}$

Estimation of population mean (μ) when σ is known

$$\mu = \bar{x} \pm z \sigma / \sqrt{n} \quad (\text{normal tables for } z)$$

Estimation of population mean (μ) for large sample size and σ unknown

$$\mu = \bar{x} \pm z s / \sqrt{n} \quad (\text{normal tables for } z)$$

Estimation of population mean (μ) for small sample size and σ unknown

$$\mu = \bar{x} \pm t s / \sqrt{n} \quad (t\text{-tables for } t)$$

When using t -tables: $v = n - 1$

Confidence intervals for paired (dependent) data

$$\mu_d = \bar{x}_d \pm t s_d / \sqrt{n_d} \quad \text{where "d" refers to the calculated differences}$$

FINANCIAL MATHEMATICS

Simple interest $A_n = P\left(1 + \frac{i}{100} \times n\right)$

Compound interest $A_n = P\left(1 + \frac{i}{100}\right)^n$

Effective APR = $\left(\left(1 + \frac{i}{100}\right)^n - 1\right) \times 100\%$

Straight line depreciation $A_s = P\left(1 - \frac{i}{100} \times n\right)$

Depreciation $A = P\left(1 - \frac{i}{100}\right)^n$

The future value of an initial investment A_0 is given by $A = A_0\left(1 + \frac{i}{100}\right)^n$ and the present value of an accumulated investment A_n is given by $A_0 = \frac{A_n}{\left(1 + \frac{i}{100}\right)^n}$ or $A\left(1 + \frac{i}{100}\right)^{-n}$

Loan account

If an annuity is purchased for a sum of A_0 at a rate of $i\%$ compounded each period then the periodic repayment is

$$R = \frac{iA_0}{1 - (1+i)^{-n}}$$

and the present value of the annuity A_0 (the loan) is

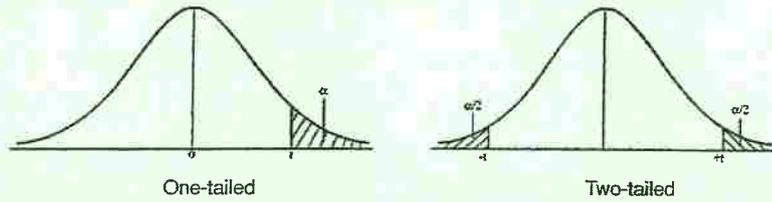
$$A_0 = R \times \frac{(1+i)^n - 1}{i(1+i)^n} \text{ or equivalently } A_0 = \frac{R[1 - (1+i)^{-n}]}{i}$$

Savings account

A savings plan/sinking fund invested for n periods at a nominal rate of $i\%$ compounded each period with a periodic investment of $\pounds P$ matures to S where

$$S = P(1+i) \times \left(\frac{(1+i)^n - 1}{i}\right)$$

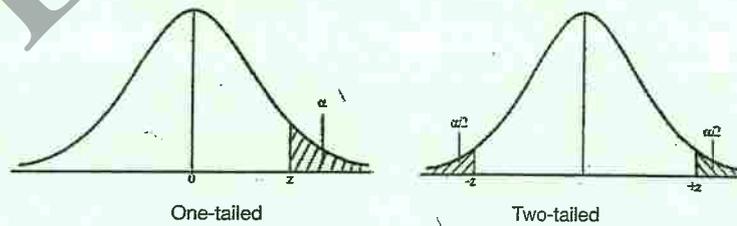
Table 2 Percentage points of the t-distribution



| One tail α | 5% | 2.5% | 1% | 0.5% | 0.1% | 0.05% |
|--------------------|------|------|-------|-------|-------|-------|
| Two tails α | 10% | 5% | 2% | 1% | 0.2% | 0.1% |
| $v = 1$ | 6.31 | 4.30 | 12.71 | 31.82 | 63.66 | 636.6 |
| 2 | 2.92 | 4.30 | 6.96 | 9.92 | 22.38 | 31.60 |
| 3 | 2.35 | 3.18 | 4.54 | 5.84 | 10.21 | 12.92 |
| 4 | 2.13 | 2.78 | 3.75 | 4.60 | 7.17 | 8.61 |
| 5 | 2.02 | 2.57 | 3.36 | 4.03 | 5.89 | 6.87 |
| 6 | 1.94 | 2.45 | 3.14 | 3.71 | 5.21 | 5.96 |
| 7 | 1.89 | 2.36 | 3.00 | 3.50 | 4.79 | 5.41 |
| 8 | 1.86 | 2.31 | 2.90 | 3.36 | 4.50 | 5.04 |
| 9 | 1.83 | 2.26 | 2.82 | 3.25 | 4.30 | 4.78 |
| 10 | 1.81 | 2.23 | 2.76 | 3.17 | 4.14 | 4.59 |
| 12 | 1.78 | 2.18 | 2.68 | 3.05 | 3.93 | 4.32 |
| 15 | 1.75 | 2.13 | 2.60 | 2.95 | 3.73 | 4.07 |
| 20 | 1.72 | 2.09 | 2.53 | 2.85 | 3.55 | 3.85 |
| 24 | 1.71 | 2.06 | 2.49 | 2.80 | 3.47 | 3.75 |
| 30 | 1.70 | 2.04 | 2.46 | 2.75 | 3.39 | 3.65 |
| 40 | 1.68 | 2.02 | 2.42 | 2.70 | 3.31 | 3.55 |
| 60 | 1.67 | 2.00 | 2.39 | 2.66 | 3.23 | 3.46 |
| ∞ | 1.64 | 1.96 | 2.33 | 2.58 | 3.09 | 3.29 |

v = degrees of freedom α = total percentage in tails

Table 3 Percentage points of the standard normal curve



| One tail | 5% | 2.5% | 1% | 0.5% | 0.1% | 0.05% |
|-----------|------|------|------|------|------|-------|
| Two tails | 10% | 5% | 2% | 1% | 0.2% | 0.1% |
| z | 1.64 | 1.96 | 2.33 | 2.58 | 3.09 | 3.29 |

α = total percentage in tails