Data Collection and Non-Linear Regression: exam practice

10 questions · 26 marks · worked solutions and markschemes

Name _____ Date _____ Score / 26

- Answer every question before you look at the solutions. They start after the last question, with the marks for each line: M for method, A for accuracy, R for reasoning.
- Online, with more practice: ibmathrevision.com/hlai/data-collection-and-non-linear-regression-exam-practice

1. **2 marks · Paper 1 style · calculator allowed**

A researcher asks every 10th person entering a shopping centre about local transport.

Name the sampling method and give one source of bias. **[2]**

2. **3 marks · Paper 1 style · calculator allowed**

The linear regression line of y on x for a dataset is given by $\hat{y} = 1.4x + 2.5$. For a specific observation $(3, k)$, the residual is exactly -0.7. Find the exact value of k.

3. **4 marks · Paper 1 style · calculator allowed**

A linear regression model $y = 3.2x + 1.5$ is used to model a dataset. One of the raw data points is $(4, 12)$.

Calculate the exact value of the residual for this data point.

4. **2 marks · Paper 2 style · calculator allowed**

Data are shown below.

x	1	2	3	4	5
y	2.7	7.4	20.1	54.6	148.4

Find the exponential regression model $y = ae^{bx}$. **[2]**

5. **2 marks · Paper 1 style · calculator allowed**

A school has 420 students in grade 11 and 380 in grade 12. A stratified sample of 40 is taken.

Find the number from each grade. **[2]**

6. **2 marks · Paper 2 style · calculator allowed**

Two models are fitted to a data set: a linear model with $R^2 = 0.82$ and a quadratic model with $R^2 = 0.97$.

State which model fits better and explain what R^2 measures. **[2]**

7. **2 marks · Paper 1 style · calculator allowed**

Classify each variable as discrete or continuous: number of siblings; reaction time; shoe size; mass of a parcel.

Classify each. **[2]**

8. **2 marks · Paper 2 style · calculator allowed**

A logarithmic model $y = a + b\ln x$ is fitted to the data.

x	1	2	3	4	5
y	4.2	6.9	8.1	9.0	9.6

Find a and b. **[2]**

9. **3 marks · Paper 2 style · calculator allowed**

A power model $y = ax^b$ is fitted to the data below.

x	1	2	3	4	5	6
y	3.1	11.8	27.5	47.6	75.2	107.9

Find a and b, and use the model to predict y when $x = 7$. **[3]**

10. **4 marks · Paper 1 style · calculator allowed**

An exponential model of the form $y = Ab^x$ passes exactly through the data points $(1, 6)$ and $(2, 18)$. Find the exact values of the constants A and b.

Answers and worked solutions

Question 1 — 2 marks

Answer: systematic sampling

systematic sampling **A1**

only people who visit the centre are surveyed **R1**

Question 2 — 3 marks

Answer: 6

Find the predicted value at $x = 3$: $\hat{y} = 1.4(3) + 2.5 = 6.7$ **(A1)**

Use residual = observed − predicted: $-0.7 = k - 6.7$ **M1**

Solve for k: $k = 6.7 - 0.7 = 6$ **A1**

Question 3 — 4 marks

Answer: -2.3

Residual = Actual y value − Predicted y value $(y - \hat{y})$. **[M1]**

Predicted y at $x = 4$: $\hat{y} = 3.2(4) + 1.5 = 12.8 + 1.5 = 14.3$. **[M1][A1]**

Residual $= 12 - 14.3 = -2.3$. **[A1]**

Question 4 — 2 marks

Answer: $y = 0.996e^{1.00x}$

GDC exponential regression **(M1)**

$y = 0.996e^{1.00x}$ **A1**

Question 5 — 2 marks

Answer: 21 and 19

$\frac{420}{800} \times 40 = 21$ **A1**

19 **A1**

Question 6 — 2 marks

Answer: the quadratic model

quadratic **A1**

the proportion of the variation in y explained by the model **R1**

Question 7 — 2 marks

Answer: discrete; continuous; discrete; continuous

discrete, continuous **A1**

discrete, continuous **A1**

Question 8 — 2 marks

Answer: $a = 4.35$, $b = 3.35$

GDC logarithmic regression **(M1)**

$a = 4.35$, $b = 3.35$ **A1**

Question 9 — 3 marks

Answer: $a = 3.06$, $b = 1.99$; 146

GDC power regression **(M1)**

$a = 3.06$, $b = 1.99$ **A1**

146 **A1**

Question 10 — 4 marks

Answer: (A) 2; (b) 3

Substitute both points: $6 = Ab$ and $18 = Ab^2$ **M1**

Divide the second equation by the first: $\frac{Ab^2}{Ab} = \frac{18}{6}$ **M1**

$b = 3$ **A1**

Substitute back: $6 = 3A \implies A = 2$ **A1**

Every solution is also on ibmathrevision.com/hlai/data-collection-and-non-linear-regression-exam-practice
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