2.5 Statistics: Hypothesis Testing: 30-minute Pack

EDEXCEL 9MA0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Historically, 20% of seeds of a certain plant fail to germinate. A gardener, Rhys, treats a random sample of 25 seeds with a new fertiliser, hoping it decreases the failure rate. Let X be the number of seeds, out of 25, that fail to germinate.

(a) State suitable hypotheses for Rhys's test. **(2)**

(b) Assuming X ~ B(25, 0.2), find the critical region for the test, using a 5% significance level. You should show the probabilities used to justify the critical region. **(4)**

(c) State the actual (achieved) significance level of the test. **(1)**

(d) In the sample, 1 of the 25 seeds failed to germinate. State, with a reason, the conclusion of the test in context. **(2)**

(Total for Question 1 is 9 marks)

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2 The number of hours of rainfall (x) and the crop yield (y, in tonnes per hectare) are recorded for 9 randomly selected farms in a region. Priya calculates the product moment correlation coefficient for the data to be r = 0.658.

(a) State suitable hypotheses to test, at the 5% significance level, whether there is positive correlation between rainfall and crop yield. **(2)**

(b) Given that the critical value for a one-tail test at the 5% significance level, with n = 9, is 0.5822, determine whether there is significant evidence of positive correlation between rainfall and crop yield. Justify your answer. **(2)**

(c) State one assumption that is necessary for this hypothesis test to be valid. **(1)**

(d) Priya's colleague, Marcus, claims that this result proves that increased rainfall causes an increase in crop yield. Comment on whether Marcus's claim is justified. **(2)**

(Total for Question 2 is 7 marks)

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3 A student records 10 pairs of values for the length of time spent revising and the test score. The product moment correlation coefficient is r = -0.539. The critical value of r for a one-tailed test with a 5% significance level and n = 10 is 0.5494.

(a) Write down suitable hypotheses to test for negative correlation. **(2)**

(b) Carry out the test and state your conclusion in context. **(3)**

(Total for Question 3 is 5 marks)

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4 The proportion of a species of tree seeds that germinate is known to be 0.5. A gardener uses a new compost and believes the proportion has decreased. She plants 12 seeds. Let p be the true probability, and X the number in the sample, so under H0, X ~ B(12, 0.5).

(a) State suitable hypotheses for the test, in terms of p. **(2)**

(b) Using a 1% significance level, find the critical region for the test. **(3)**

(c) Write down the actual significance level of the test, and state the probability of a Type I error. **(2)**

(Total for Question 4 is 7 marks)

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Mark scheme · 2.5 Statistics: Hypothesis Testing: 30-minute Pack

Question 1

(a) H0: p = 0.2, where p is the probability a seed fails to germinate **B1**

(a) H1: p < 0.2 (oe, one-tail test) **B1**

(a) Answer: H0: p = 0.2, H1: p < 0.2

(b) attempt to find P(X≤1) or P(X≤2) using B(25,0.2) **M1**

(b) P(X≤1) = 0.0274 (awrt) **A1**

(b) P(X≤2) = 0.0982 (awrt), showing 0.0274 ≤ 0.05 < 0.0982 **A1**

(b) correct critical region: X ≤ 1 (cao) **A1**

(b) Answer: Critical region: X ≤ 1

(c) actual significance level = 0.0274 (2.74%) (ft) **B1**

(c) Answer: 2.74%

(d) 1 lies in the critical region {0,1} (ft) **M1**

(d) reject H0; evidence, at the 5% level, that the fertiliser has decreased the probability a seed fails to germinate **A1**

(d) Answer: Since X = 1 is in the critical region, reject H0; there is evidence the fertiliser has decreased the failure probability.

Question 2

(a) H0: ρ = 0, where ρ is the population product moment correlation coefficient **B1**

(a) H1: ρ > 0 (oe, one-tail test) **B1**

(a) Answer: H0: ρ = 0, H1: ρ > 0

(b) compare r = 0.658 with the critical value 0.5822 **M1**

(b) 0.658 > 0.5822 so reject H0; significant evidence of positive correlation between rainfall and crop yield **A1**

(b) Answer: 0.658 > 0.5822, so reject H0; significant evidence of positive correlation.

(c) the pairs (rainfall, crop yield) come from a population that follows a bivariate normal distribution (oe) **B1**

(c) Answer: The population of (rainfall, crop yield) pairs is bivariate normally distributed.

(d) correlation does not imply causation **B1**

(d) there may be other factors (e.g. soil quality, temperature, farming practice) that affect crop yield, so causation cannot be concluded from correlation alone (oe) **B1**

(d) Answer: No, Marcus's claim is not justified; correlation does not prove causation, as other factors could explain the relationship.

Question 3

(a) H0: ρ = 0 **B1**

(a) H1: ρ < 0 **B1**

(a) Answer: H0: ρ = 0, H1: ρ < 0

(b) compares |r| = 0.539 with the critical value 0.5494 in the correct tail **M1**

(b) do not reject H0 **A1**

(b) there is insufficient evidence of negative correlation **B1**

(b) Answer: do not reject H0

Question 4

(a) H0: p = 0.5 **B1**

(a) H1: p < 0.5 **B1**

(a) Answer: H0: p = 0.5, H1: p < 0.5

(b) uses the binomial distribution B(12, 0.5) to find cumulative probabilities near the tail **M1**

(b) P(X ≤ 1) = 0.003174 ≤ 0.01 **A1**

(b) critical region: X ≤ 1 **A1**

(b) Answer: critical region X ≤ 1

(c) actual significance level = 0.00317 **B1**

(c) this is the probability of a Type I error (rejecting H0 when it is true) **B1**

(c) Answer: 0.00317

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