Author: Naga Karthik

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3·6: Approximating a binomial distribution

① a) $X \sim B(250, 0.9)$ i) Not suitable, p not close to 0.5

b) $X \sim B(12, 0.48)$ i) Not suitable, n not large

c) $X \sim B(120, 0.52)$ i) Suitable as n is large and p is close to 0.5

ii) $Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow N(62.4, 5.47^2)$ (3sf)

d) $X \sim B(420, 0.45)$ i) Suitable as n is large and p is close to 0.5

ii) $Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow N(189, 10.2^2)$ (3sf)

e) $X \sim B(600, 0.54)$ i) Suitable as n is large and p is close to 0.5

ii) $Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow N(324, 12.2^2)$ (3sf)

f) $X \sim B(800, 0.74)$ i) Not suitable as the p is not close to 0.5

② $X \sim B(300, 0.47) \Rightarrow Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow N(141, 8.64^2)$ (3sf)

a) $P(X \leq 140) \Rightarrow P(Y < 140.5) = 0.4769$ (4dp)

b) $P(120 \leq X \leq 160) \Rightarrow P(119.5 < X < 160.5) = 0.9815$ (4dp)

c) $P(X = 150) \Rightarrow P(149.5 < Y < 150.5) = 0.0268$ (3sf)

③ $X \sim B(250, 0.52) \Rightarrow Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow N(130, 7.9^2)$ (3sf)

a) $P(X > 120) \Rightarrow P(Y > 120.5) = 0.8854$ (4dp)

b) $P(115 < X < 150) \Rightarrow P(115.5 < Y < 149.5) = 0.9600$ (4dp)

c) $P(X = 125) \Rightarrow P(124.5 < Y < 125.5) = 0.0413$ (3sf)

④ $X \sim B(125, 0.5) \Rightarrow Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow N(62.5, 5.59^2)$ ← Probability of even scores → 2, 4, 6 = 3/6 = 1/2 = 0.5

$P(X > 60) \Rightarrow P(Y > 60.5) = 0.6397$

⑤ $X \sim B(15, 0.56)$

a) $P(X = 10) = 0.1502$

b) $X \sim B(250, 0.56) \Rightarrow Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow N(140, 7.85^2)$ (3sf)

$P(X < 130) \Rightarrow P(Y < 129.5) \Rightarrow 0.0905$ (4dp)

c) $P(Y \geq q) = 0.1 \Rightarrow q = 150$

⑥ $X \sim B(80, 0.47)$

a) $P(X = 40) \Rightarrow 0.0770$

b) $Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow Y \sim N(37.6, 4.46^2)$

$\Rightarrow P(X = 40) = P(39.5 < Y < 40.5) = 0.0770$

Error % $\Rightarrow \left(\frac{0.0772 - 0.0770}{0.0770}\right) \times 100 = 0.3\%$ (1sf)

⑦ $X \sim B(220, 0.55)$

a) The student did not apply the continuity correction

$\Rightarrow P(X \leq 110) \approx P(Y \leq 110.5)$

b) $Y \sim N\left(np, \left[\sqrt{np(1-p)}\right]^2\right) \Rightarrow Y \sim N(121, 7.38^2)$ (3sf)

$\Rightarrow P(Y \leq 110.5) = 0.0774$ (3sf)

c) $P(X > 130) = P(Y > 130.5) = 0.099$ (2sf)

d) $P(105 < X < 120) = P(105.5 < Y < 119.5) = 0.4016$ (4sf)