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8.5 Binomial Estimation

1) a) $(1-\frac{x}{5})^9$

$1^9 + ({}^9C_1)1^8(-\frac{x}{5}) + 1^7({}^9C_2)(-\frac{x}{5})^2 + 1^6({}^9C_3)(-\frac{x}{5})^3$

$= 1 - \frac{9}{5}x + \frac{36}{25}x^2 - \frac{84}{125}x^3$

b) $(0.985)^9 = (1-\frac{x}{5})^9$

$1 - \frac{x}{5} = 0.985$

$\frac{x}{5} = 0.015$

$x = 0.075$

$1 - \frac{9}{5}(0.075) + \frac{36}{25}(0.075)^2 - \frac{84}{125}(0.075)^3$

$= 0.8728165$

↳ 0.8728 (4 d.p.)

2) a) $(1-2x)^6$

$1^6 + ({}^6C_1)1^5(-2x) + ({}^6C_2)1^4(-2x)^2$

$= 1 - 12x + 60x^2$

b) $(1-12x+60x^2)(3+x)$

$3 + x - 36x - 12x^2 + 180x^2 + 60x^3$

↳ ignored

$= 3 - 35x + 168x^2$

3) a) $(3+\frac{x}{4})^8$

$3^8 + ({}^8C_1)3^7(\frac{1}{4}x) + 3^6({}^8C_2)(\frac{1}{4}x)^2 + ({}^8C_3)(\frac{1}{4}x)^3$

$= 6561 + 4374x + \frac{5103}{4}x^2 + \frac{1701}{8}x^3$

b) $(3\cdot05)^8 = (3+\frac{x}{4})^8$

$3+\frac{x}{4} = 3\cdot05$

$\frac{x}{4} = 0\cdot05$

$x = 0\cdot2$

$6561 + 4374(0\cdot2) + \frac{5103}{4}(0\cdot2)^2 + \frac{1701}{8}(0\cdot2)^3$

$= 7488\cdot531$

4) a) $(1+\frac{x}{4})^9$

$1^9 + ({}^9C_1)1^8(\frac{x}{4}) + ({}^9C_2)1^7(\frac{x}{4})^2 + ({}^9C_3)1^6(\frac{x}{4})^3$

$= 1 + \frac{9}{4}x + \frac{9}{4}x^2 + \frac{21}{16}x^3$

b) $(1+\frac{x}{4})^9 = (1\cdot015)^9$

$1+\frac{x}{4} = 1\cdot015$

$\frac{x}{4} = 0\cdot015$

$x = 0\cdot06$

$1 + \frac{9}{4}(0\cdot06) + \frac{9}{4}(0\cdot06)^2 + \frac{21}{16}(0\cdot06)^3$

$= 1\cdot1433835$

↳ $1\cdot143$ (3 d.p.)

5) a) $(1-3x)^6$

$1^6 + ({}^6C_1)1^5(-3x) + ({}^6C_2)1^4(-3x)^2 + ({}^6C_3)1^3(-3x)^3$

$= 1 - 18x + 135x^2 - 540x^3$

b) $(1-18x+135x^2-540x^3)(1+\frac{x}{2})$

$1 - 18x + 135x^2 - \cancel{540x^3} + \frac{1}{2}x - 9x^2 + \cancel{\frac{135}{2}x^3}$

$\cancel{-270x^4}$ ← ignored

$= 1 - \frac{35}{2}x + 126x^2$

6) a) $(2-\frac{x}{2})^7$

$2^7 + ({}^7C_1)\,2^6(-\frac{1}{2}x) + ({}^7C_2)\,2^5(-\frac{1}{2}x)^2$

$= 128 - 224x + 168x^2$

b) You have to substitute $x = 0.03$ into the expansion.

7) a) $(3-\frac{x}{5})^{10}$

$3^{10} + ({}^{10}C_1)\,3^9(-\frac{1}{5}x) + ({}^{10}C_2)\,3^8(-\frac{1}{5}x)^2 + ({}^{10}C_3)\,3^7(-\frac{1}{5}x)^3$

$= 59049 - 39366x + \frac{59049}{5}x^2 - \frac{52488}{25}x^3$

b) $(2.995)^{10} = (3-\frac{x}{5})^{10}$

$3 - \frac{x}{5} = 2.995$

$\frac{x}{5} = 0.005$

$x = 0.025$

$59049 - 39366(0.025) + \frac{59049}{5}(0.025)^2 - \frac{52488}{25}(0.025)^3$

$= 58072.198320$

c) $(2.995)^{10} = 58072.19842$

$\frac{58072.19842 - 58072.198320}{58072.19842} \times 100$

$= 1.64 \times 10^{-7}\%$