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3.2 Finding probabilities for normal distributions

① $X \sim N(40, 4^2)$

a) $P(X < 43) = 0.7734$ b) $P(X > 36) = 0.8413$

c) $P(X \geqslant 38.6) = 0.6368$

② $X \sim N(50, 25)$

a) $P(X > 58) = 0.0548$ b) $P(X \leq 45) = 0.1587$

c) $P(45 < X < 57) = 0.7606$

③ $Y \sim N(36, 36 = 6^2)$

a) $P(Y < 30) = 0.1587$ b) $P(30 < Y < 40) = 0.5889$

c) $P(Y > 31.7) = 0.7632$

④ $X \sim N(22, 8)$

a) $P(X > 20) = 0.7602$ b) $P(X < 18) = 0.0786$

c) $P(20.5 < X < 21.8) = 0.1739$

⑤ $M \sim N(10, 1.2^2)$

a) i) $P(M > 11) = 0.2023$ ii) $P(M < 11) = 0.7977$

b) $0.2023 + 0.7977 = 1$; $P(M > 11) + P(M < 11) = 1$; $P(M = 11) = 0$

⑥ $T \sim N(5.2, 0.5)$

a) $P(T < 4.8) = 0.2858$ b) $P(T > 4.8) = 1 - P(T < 4.8) = 1 - 0.2858 = 0.7142$

⑦ $Y \sim N(62, 5^2)$

a) $P(Y < 58 \text{ or } Y > 65) = 1 - P(58 < Y < 65) = 1 - 0.5139 = 0.4861$

b) $P(Y < 60 \text{ or } 65 < Y < 70) = 0.3445 + 0.2194 = 0.5640$

⑧ $L \sim N(100, 2.5^2)$

a) i) $P(L>104) = 0.0548$ ii) $P(L<99) = 0.3446$

b) $P(L>99) \Rightarrow X \sim B(100, 0.6554) = (0.6554)^5 = 0.1209$

$1 - 0.3446$

⑨ $X \sim N(80, 12^2)$

a) i) $P(X>90) = 0.2023$ ii) $P(X<65) = 0.1056$

b) $P(X<60) = 0.0477$; $P(Y \geq 3) = 1 - P(Y \leq 2)$ $X \sim B(25, 0.0477)$

$\Rightarrow 1 - [P(Y=0) + P(Y=1) + P(Y=2)]$

$\Rightarrow P(Y=0) = (1-0.0477)^{25} = 0.294675893$

$\Rightarrow P(Y=1) = \binom{25}{1}(0.9523)^{24}(0.0477) = 0.3690024177$

$\Rightarrow P(Y=2) = \binom{25}{2}(0.9523)^{23}(0.0477)^2 = 0.2217966858$

$P(Y \leq 2) = 0.8854749964 \Rightarrow 1 - P(Y \leq 2) = 0.11452\ldots$

$= 0.1150$

⑩ $J \sim N(454, 5.6^2)$

a) $P(J>460) = 0.1420$ b) $P(452 < J < 458) = 0.4020$

c) $P(X \geq 15) = 1 - P(X \leq 15) = 1 - 0.9998 = 0.0002$

$X \sim B(18, 0.4020)$

⑪ a) $H \sim N(165, 4.8^2)$ $W \sim N(65, 6.7^2)$

$\Rightarrow P(H>170) = 0.1487$ $\Rightarrow P(W>68) = 0.3271$ $\Rightarrow P(H>170 \cap W>68)$

$\Rightarrow 0.1487 \times 0.3271 = 0.0487$ (3sf)

b) The height of an athlete is likely to have an effect on the athlete's weight, so the assumption of independence is not sensible.