

Effect of transformations on variance and standard deviation, $\text{Var}(X)$

Adding: when we **add the same number**, b , to each value, the **variance remains unchanged** (i.e. the spread of the data does not change).

Multiply: what happens though when we multiply each value by a ?

Proof:
$$\begin{aligned}\text{Var}(aX) &= E(aX)^2 - E^2(aX) \\ &= E(a^2X^2) - [E(aX)]^2 \\ &= a^2E(X^2) - [aE(X)]^2 \\ &= a^2(E(X^2) - [E(X)]^2) \\ &= a^2(E(X^2) - E^2(X)) \\ &= a^2\text{Var}(X)\end{aligned}$$

In general, **$\text{Var}(aX + b) = a^2\text{Var}(X)$**

E.g. 2 Find the exact value of $\text{Var}(2X + 3)$ for the discrete random variable X that has probability distribution:

x :	1	2	3	4
$P(X = x)$:	0.375	0.125	0.25	0.25

Video: [Linear combinations of discrete random variables](#)

[Discrete random variable EQ](#)

[Solutions to Starter and E.g.s](#)

Exercise

p27 2B Qu 1i, 2-6, (7 red)

Summary

$$E(aX + b) = aE(X) + b$$

$$\text{Var}(aX + b) = a^2\text{Var}(X)$$

Reminder: $\mu = E(X) = \sum xP(X = x)$

$$\text{Var}(X) = E(X^2) - E^2(X)$$

Standard, deviation $\sigma = \sqrt{\text{Var}(X)}$