Random variable (population term)	vector (sample term)
X_1 = heart rate random variable	x_1 = heart rate vector provided sample of 100 patients $\Rightarrow x_1 = \begin{bmatrix} 96 \\ 28 \\ 84 \\ \vdots \\ 110 \end{bmatrix}$
$Y_1 = E[X_1]$ ⇒ expected value of X_1 ⇒ heart rate distribution random variable	$x_1 - \text{avg}(x_1) = \begin{bmatrix} 96 \\ 28 \\ 84 \\ \vdots \\ 110 \end{bmatrix} - 75 =$ approximation for $E[X_1]$ ⇒ deviation vector
$(X_1 - E[X_1])^2$ heart rate squared deviation random variable	$[x_1 - \text{avg}(x_1)]^2 = \begin{bmatrix} (21)^2 \\ (-5)^2 \\ (9)^2 \\ \vdots \\ (35)^2 \end{bmatrix}$ ⇒ Square deviations vector.
$E[(X_1 - E[X_1])^2]$ = Var$[X_1]$ (variance) ⇒ variance of the heart rate BPM^2	⇒ avg (square deviations vector) ⇒ avg $(E X_1 - \text{avg}(x_1)]^2$ $= \frac{(-3)^2 + (-5)^2 + (9)^2 + \dots + (37)^2}{100}$ ⇒ Sample variance of the heart rate BPM^2
$\sqrt{E[(X_1 - E[X_1])^2]}$ ⇒ Standard deviation ⇒ SD$[X]$ Standard deviation of the heart rate (BPM)	$\sqrt{\text{Sample variance value}}$ $\sqrt{\frac{(-3)^2 + (-5)^2 + (9)^2 \dots}{100}}$ (BPM) Sample Standard deviation of the heart rate

problem set - 4
box - 10 balls → 4 white, 6 black
pick 5 → $^{10}C_5$ (randomly picked)
probability of exactly 3 balls in this 3 are white → $\binom{5}{3}$

i) with replacement ⇒
pick 3 balls out 4 white balls with replacement & order matters
and
pick 2 black balls out of black with replacement & order matters.
$\binom{5}{3} \times$ (3 out 4) $\times$ (2 out 6).
sampling set $\dot{w}\dot{w}\dot{w}\dot{w}, \dot{w}\dot{w}\dot{w}\dot{w} \dots \dot{w}\dot{w}\dot{w}\dot{w}$
4 out of 10 are white, pick 3 such.
6 out of 10 are black pick 2 such.
$\binom{5}{3} \times \left(\frac{4}{10} \times \frac{4}{10} \times \frac{4}{10}\right) \times \left(\frac{6}{10} \times \frac{6}{10}\right)$
$\binom{5}{3} \left(\frac{4}{10}\right)^3 \left(\frac{6}{10}\right)^2$ ⇒ Binomial formula.
$\binom{n}{n_1} (p)^{n_1} \times (1-p)^{n-n_1}$ ⇒ $10 \times (0.4)^3 \times (0.6)^2$

ii) with out replacement ⇒ hypergeometric.
chose 5 of 10 balls ⇒ $^{10}C_5$
chose 3 of 4 white blocks ⇒ $^4C_3$
chose 2 of 6 black balls ⇒ $^6C_2$ $N = 10$ $n = 5$
$\frac{\binom{R}{x} \times \binom{N-R}{n-x}}{\binom{N}{n}}$ $R = 4$ $x = 3$
$N - R = 6$, $n - x = 2$

$\frac{\binom{4}{3} \times \binom{6}{2}}{\binom{10}{5}}$ $\frac{4 \times 15}{252}$

binomial ⇒ one outcome is independent of other outcome
here the previous pick don't effect the next pick.

hypergeometric distribution ⇒ one outcome influence the other outcome
here the previous pick is not picked again which change the probability of next coming pick probability.