RANDOM VARIABLE: $S \xrightarrow{X} R \xrightarrow{P} [0,1] \ni \int_S XP = \int_R P = 1$

EXPECTATION: $E(X) = \int_R x p(x)\,dx$ OR $\sum_i x_i p(x_i)$ 'AVERAGE RETURN' X \$ $p(x)$ EXPECT $E(X)$ ON THE AVERAGE
FLIP COIN: $H \to \$1$, $T \to \$0$, $E(X) = 50¢$

$$E(AX) = AE(X) \quad E(X+Y) = E(X)+E(Y) \quad E(A) = A$$

VARIANCE: $E\left[(X-E(X))(X-E(X))'\right] = V(X)$

FOR SCALAR X $= E((X-E(X))^2) = E(X^2 - 2XE(X) + E(X)^2)$
$= E(X^2) - E(2XE(X)) + E(E(X)^2)$
$= E(X^2) - 2E(XE(X)) + E(X)^2$
$= E(X^2) - 2E(X)E(X) + E(X)^2$
$= E(X^2) - 2E(X)^2 + E(X)^2$
$= E(X^2) - E(X)^2$

COVARIANCE: $\mathrm{Cov}(X,Y) = E((X-E(X))(Y-E(Y))') = E(XY') - E(X)E(Y)'$
$\therefore V(X) = \mathrm{Cov}(X,X)$

CORRELATION: $R(X,Y) = \dfrac{\mathrm{Cov}(X,Y)}{\sqrt{V(X)V(Y)}}$

$$X \sim N(\mu, \sigma^2) \qquad \left.\begin{aligned} AX &\sim N(A\mu, A^2\sigma^2) \\ X+A &\sim N(\mu+A, \sigma^2) \end{aligned}\right\} \qquad Y \sim N(\lambda, \xi^2) \qquad (X+Y) \sim N(\mu+\lambda, \sigma^2+\xi^2+2\mathrm{Cov}(X,Y))$$

$$\frac{X-\mu}{\sqrt{\sigma^2}} \sim N(0,1)$$

$\phi_i \sim N(0,1)$ $\quad \sum_{i=1}^{N} \phi_i^2 \sim \chi^2_{(N)}$ $\quad \phi_i$'S UNCORRELATED

$$E(\chi^2_{(N)}) = N \quad V(\chi^2_{(N)}) = 2N \quad E\left(\frac{\chi^2_{(N)}}{N}\right) = 1 \quad V\left(\frac{\chi^2_{(N)}}{N}\right) = \frac{2}{N}$$

$$t_{(N)} = \frac{\phi}{\sqrt{\chi^2_{(N)}/N}} \qquad t_{(\infty)} = \phi$$

$$F_{(M,N)} = \frac{\chi^2_{(M)}/M}{\chi^2_{(N)}/N} \qquad F_{(1,N)} = \frac{\chi^2_{(1)}/1}{\chi^2_{(N)}/N} = \frac{\phi^2}{\chi^2_{(N)}/N} = t^2_{(N)}$$

ONLY $N(0,1)$ DISTRIBUTION IS TABLED AMONG THE NORMALS $\therefore$ MUST USE STANDARDIZED SCORES $\left(\frac{X-\mu}{\sqrt{\sigma^2}}\right)$ TO GET PROBABILITIES