Joint distribution:
For the discrete case of two variables \( x, y \) the following are joint probabilities

\[
P(X = x, Y = y) = P(x, y) \\
P((X, Y) \in B) = \sum_{(x,y) \in B} P(x, y),
\]

with

\[P(x, y) \geq 0, \quad \sum_{x} \sum_{y} P(x, y) = 1.\]

For the continuous case of two variables \( x, y \) the following is a joint probability density

\[
P(X \in dx, Y \in dy) = f(x, y)dx \, dy
\]

with

\[f(x, y) \geq 0, \quad \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(x, y)dx \, dy = 1,
\]

and

\[
P((X, Y) \in B) = \int_{(x,y) \in B} f(x, y) \, dx \, dy,
\]

Marginals:
For discrete distributions

\[
P(X = x) = \sum_y P(x, y),
\\
P(Y = y) = \sum_x P(x, y).
\]

For continuous distributions

\[
f_X(x) = \int_{y=-\infty}^{\infty} f(x, y)dy,
\\
f_Y(y) = \int_{x=-\infty}^{\infty} f(x, y)dx.
\]

Independence:
For discrete distributions

\[P(x, y) = P(X = x)P(Y = y).\]

For continuous distributions

\[f(x, y) = f_X(x)f_Y(y).\]
Covariance:
The covariance of two random variables $X$ and $Y$ is
\[ \text{Cov}(X, Y) = \mathbb{E}[(X - \mu_X)(Y - \mu_Y)], \quad \mu_X = \mathbb{E}[X], \quad \mu_Y = \mathbb{E}[Y], \]
and
\[ \text{Var}(X + Y) = \text{Var}(X) + \text{Var}(Y) + 2 \text{Cov}(X, Y). \]

Correlation:
The correlation between two random variables $X$ and $Y$ is
\[ \text{Corr}(X < Y) = \frac{\text{Cov}(X, Y)}{\sigma_X \sigma_Y}. \]