$P(A) = \frac{\text{Number of favorable outcome}}{\text{Total number of event}}$ $P(A^c) = 1 - P(A)$ $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$P(A \cap B) = P(A) \cdot P(B)$ iff independent. Not mutually exclusive !!

$P(A|B) = \frac{P(A \cap B)}{P(B)}$ where $(P(B) > 0) = \frac{P(B|A) \cdot P(A)}{P(B)}$, $P(A \cap B) = P(A|B) \cdot P(B)$

~~$P(B) = \sum_{A_i} P(B|A_i) \cdot P(A_i)$ where A_i is partition of the event space.~~

$P(B|C) = \tilde{P}(B) = \sum_{A_i} \tilde{P}(B|A_i) \cdot \tilde{P}(A_i) = \sum P(B|A_i \cap C) \cdot P(A_i|C)$

order with replacement $\equiv n^r$ unordered with replacement $= \binom{n+r-1}{r}$, order $= 123 \neq 132$, unorder $= 123 = 321$.

order with no replacement $= P = \frac{n!}{(n-r)!} = n(n-1)(n-2)\ldots(n-r+1)$

Unordered with no replacement $= C = \frac{n!}{r!(n-r)!}$

$\sum_{i=1}^{n} a \cdot r^{i-1} = S_n = \frac{a(1-r^n)}{1-r}$, if $|r|<1$ and $n \to \infty$, then $S_n = \frac{a}{1-r}$

PMF $= P(X = x)$ Bernoulli: P success $= p$, failure $= 1-p$. If P(success $= r$), then = binomial

$\binom{n}{k} p^k (1-p)^{n-k} \to P(\text{Success} \geq r) = 1 - P(\text{Success} < r)$ ← some # of trials.

~~Poisson: $P(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}$ where λ = average per given amount.~~

~~↑ events are rare relative to the interval, total number of fixed interval.~~

~~Number of occurrence in a fixed interval~~

CDF $= P(X \leq x_0) = P(X = u \leq x_0) = F_X(x_0)$, pdf $= \frac{d}{dx} F_X(x_0) = f_X(x_0)$.

CDF $= \int_{-\infty}^{x_0} f_X(u)\,du$. Gaussian $= Z = \frac{X-\mu}{\sigma}$ ← make it a std !!, Q function $= P(X > x)$.

For continuous, $P(X = x) = 0$. $F_X(x \to \infty) = 1$, $F_X(x \to -\infty) = 0$.

$P(a < X < b) = \int_a^b f_X(x)\,dx$. N ~ pdf $= \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$, exp: $f_X(x) = \lambda e^{-\lambda x}$, $F_X(x) = 1 - e^{-\lambda x}$

↑ start at $x=0$, $f=0$.

Uniform: $P(a < X < b)$: pdf $= \frac{1}{b-a}$, cdf $= 0$ $x < a$, $\frac{x-a}{b-a}$ if $x \geq b$, $x \leq a$.

1 If $x > b$.

Conditional PDF: $f_{X|Y}(x,y) = f_{XY}(x,y) / f_Y(y)$, $f_Y(y) = \int_{-\infty}^{\infty} f_{XY}(x,y)\,dx$ ← all x.

R.V. $= P(X \leq x) = P(X(s) = u \leq x) = \{s \mid X(s) = u \leq x\}$

Total probability: $f_X(x) = \sum_{i=1} f_X(x|A_i) \cdot P(A_i)$ Bayes: $f_X(x|A) = \frac{P(A|X=x) f_X(x)}{P(A)}$

$P(A|X=x) = f_X(x|A) \cdot P(A) / f_X(x)$