

BIE-PST Cheat Sheet

FIT – CTU in Prague
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Probability	$P(A) = \frac{ A }{ \Omega } = \frac{\# \text{ of favorable outcomes}}{\# \text{ of all outcomes}}$ or $\frac{\text{size of favorable outcomes}}{\text{size of all outcomes}}$
Conditional probability	$P(A B) = \frac{P(A \cap B)}{P(B)}$
Multiplicative law	$P(A_1 \cap \dots \cap A_n) = P(A_1) P(A_2 A_1) \dots P(A_n A_1 \cap \dots \cap A_{n-1})$
Law of total probability	$P(A) = \sum_j P(A B_j)P(B_j)$
Bayes' Theorem	$P(B_i A) = \frac{P(A B_i)P(B_i)}{\sum_j P(A B_j)P(B_j)}$
Independence	$P(A \cap B) = P(A)P(B)$

Distribution function	$F_X(x) = P(X \leq x)$	
	Discrete random variable X	Continuous random variable X
Probabilities of values / Density:	$P(X = x)$	$f_X(x)$
Expectation: $E X$	$\sum_k x_k P(X = x_k)$	$\int_{-\infty}^{+\infty} x f_X(x) dx$
Expectation of a function: $E g(X)$	$\sum_k g(x_k) P(X = x_k)$	$\int_{-\infty}^{+\infty} g(x) f_X(x) dx$
Variance X : $\text{var}(X)$	$E(X - E X)^2 = E X^2 - (E X)^2$	

Distribution <i>support</i>	probability / density $P(X = k) / f_X(x)$	distribution $F_X(x) = P(X \leq x)$	expectation $E X$	variance $\text{var } X$
Bernoulli $k = 0, 1$	$\begin{cases} p, & k = 1 \\ 1 - p, & k = 0 \end{cases}$	$0; 1 - p; 1$	p	$p(1 - p)$
Binomial $k = 0, \dots, n$	$\binom{n}{k} p^k (1 - p)^{n-k}$	$\sum_{i=0}^{\lfloor x \rfloor} \binom{n}{i} p^i (1 - p)^{n-i}$	np	$np(1 - p)$
Geometric $k = 1, 2, \dots$	$(1 - p)^{k-1} p$	$1 - (1 - p)^{\lfloor x \rfloor}$	$\frac{1}{p}$	$\frac{1 - p}{p^2}$
Poisson $k = 0, 1, \dots$	$\frac{\lambda^k}{k!} e^{-\lambda}$	$e^{-\lambda} \sum_{i=0}^{\lfloor x \rfloor} \frac{\lambda^i}{i!}$	λ	λ
Uniform $a \leq x \leq b$	$\frac{1}{b - a}$	$\frac{x - a}{b - a}$	$\frac{a + b}{2}$	$\frac{(b - a)^2}{12}$
Exponential $x \geq 0$	$\lambda e^{-\lambda x}$	$1 - e^{-\lambda x}$	$\frac{1}{\lambda}$	$\frac{1}{\lambda^2}$
Normal $x \in \mathbb{R}$	$\frac{1}{\sqrt{2\pi}\sigma^2} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$	$\Phi(x)$	μ	σ^2

Joint distribution function	
$F_{X,Y}(x, y) = P(X \leq x \cap Y \leq y)$	
Discrete X and Y	Continuous X and Y
Joint probabilities $P(X = x \cap Y = y)$	Joint density $f_{X,Y}(x, y)$
Marginal distribution X	
$P(X = x) = \sum_y P(X = x \cap Y = y)$	$f_X(x) = \int_{-\infty}^{+\infty} f_{X,Y}(x, y) dy$
Independence of X and Y	
$P(X = x \cap Y = y) = P(X = x) P(Y = y)$	$f_{X,Y}(x, y) = f_X(x) f_Y(y)$
Expectation of $E g(X, Y)$	
$\sum_{x,y} g(x, y) P(X = x \cap Y = y)$	$\int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} g(x, y) f_{X,Y}(x, y) dx dy$
Conditional distribution of X given $Y = y$:	
$P(X = x Y = y) = \frac{P(X = x \cap Y = y)}{P(Y = y)}$	$f_{X Y}(x y) = \frac{f_{X,Y}(x, y)}{f_Y(y)}$
Conditional expectation of X given $Y = y$:	
$E(X Y = y) = \sum_x x P(X = x Y = y)$	$E(X Y = y) = \int_{-\infty}^{+\infty} x f_{X Y}(x y) dx$

Central Limit Theorem $Z_n = \frac{S_n - n\mu}{\sqrt{n\sigma^2}} = \frac{\bar{X}_n - \mu}{\sqrt{\sigma^2/n}} \xrightarrow{\mathcal{D}} N(0, 1)$

Sample mean	$\bar{X}_n = \frac{1}{n} \sum_{i=1}^n X_i$
Sample variance	$s_n^2 = s_X^2 = \frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X}_n)^2$
Two-sided C.I. for μ with known σ^2	$\left(\bar{X}_n - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}, \bar{X}_n + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} \right)$
Two-sided C.I. for μ with unknown σ^2	$\left(\bar{X}_n - t_{\frac{\alpha}{2}, n-1} \frac{s_n}{\sqrt{n}}, \bar{X}_n + t_{\frac{\alpha}{2}, n-1} \frac{s_n}{\sqrt{n}} \right)$
Two-sided C.I. for σ^2	$\left(\frac{(n-1)s_n^2}{\chi_{\frac{\alpha}{2}, n-1}^2}, \frac{(n-1)s_n^2}{\chi_{1-\frac{\alpha}{2}, n-1}^2} \right)$