155+

STATISTICS SYMBOLS

Cheat Sheet

Present by

SymbolALL

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List of Probability and Statistics Symbols

Symbol Name	Used For	Example
X, Y, Z, T	Random variables	$E(X1+X2)=$ $E(X1)+E(X2)$
x, y, z, t	Values of random variable	For all $x \in N0$, $P(X=x)=$ $(0.25)x(0.75)$.
n	Sample size	$X—n=X1+\cdots+Xnn$
f	Frequency of data	$f1+\cdots+fk=n$
μ (Mu)	Population mean	$H0:\mu1=\mu2$
σ (Sigma)	Population standard deviation	$\sigma X=\sum(Xi-\mu x)2n$
s	Sample standard deviation	$s=\sum(Xi-X—)2n-1$
π (Pi)	Population proportion	$Ha:\pi1\neq\pi2$

p^	Sample proportion	If $\pi1=\pi2$, use p^$=x1+x2n1+n2$ instead of p^1 or p^2.
p	Probability of success	In a standard die-tossing experiment, p=16.
q	Probability of failure	$q=1-p$
ρ (Rho)	Population correlation	$\rho X,X=1$
r	Sample correlation	$rxy=ryx$
z	Z-score	$z=x-\mu\sigma$
α (Alpha)	Significance level (probability of type I error)	At $\alpha=0.05$, the null hypothesis is rejected, but not at $\alpha=0.01$.
β (Beta)	Probability of type II error	$P(H0$rejected| $H0$false$)=1-\beta$
b	Sample regression coefficient	$y=b0+b1x1+b2x2$

β (Beta)	Population regression coefficient, Standardized regression coefficient	If $\beta 1$=0.51 and $\beta 2$=0.8, then $x2$ has more “influence” on y than $x1$.
ν (Nu)	Degree of freedom (df)	Gamma(ν/2,1/2) =$\chi 2(\nu)$
Ω (Capital omega)	Sample space	For a double-coin-toss experiment, Ω={HH,HT,TH, TT}.
ω (Omega)	Outcome from sample space	$P(X \in A)= P(\{\omega \in \Omega \mid X(\omega) \in A\})$
θ (Theta), β (Beta)	Population parameters	For normal distributions, $\theta=(\mu,\sigma)$.

Operators

Combinatorial Operators

Symbol Name	Explanation	Example
$n!$	Factorial	4!=4·3·2·1
$n!!$	Double factorial	8!!=8·6·4·2
$!n$	Number of **de-range-ments** of n objects	Since $\{a,b,c\}$ has 2 permutations where all letter positions are changed, !3=2.
nPr	Permutation (**n permute r**)	6P3=6·5·4
nCr, (nr)	Combination (**n choose r**)	(nk)=$(nn−k)$
$(nr1,…,rk)$	Multinomial coefficient	(105,3,2)=10!5!3!2!
$((nr))$	Multiset coefficient (**n multichoose r**)	From a 5-element-set, ((53)) 3-element-multisets can be taken.

Probability-related Operators

Symbol Name	Explanation	Example
$P(A)$, $\Pr(A)$	Probability of event A	$P(X\geq5)=$ $1-P(X<5)$
$P(A')$, $P(Ac)$	Complementary probability (Probability of 'not A')	For all events E, $P(E)+P(E')=1$.
$P(A\cup B)$	Disjunctive probability (Probability of 'A or B')	$P(A\cup B)\geq$ $\max(P(A),P(B))$
$P(A\cap B)$	Joint probability (Probability of 'A and B')	Events A and B are mutually exclusive when $P(A\cap B)=0$.
$P(A\|B)$	Conditional probability (Probability of 'A given B')	$P(A\|B)=P(A\cap B)P(B)$
$E[X]$	Mean / Expected value of random variable X	$E[2f(X)+5]=$ $2E[f(X)]+5$

$E[X\|Y]$	**Conditional expectation** (Expected value of X given Y)	$E[X\|Y=1]\neq E[X\|Y=2]$
$V(X)$,Var(X)	**Variance** of random variable X	$V(X)=E[X2]+E[X]2$
$V(X\|Y)$,Var$(X\|Y)$	**Conditional variance** (Variance of X given Y)	$V[X\|Y]=E[(X-E[X\|Y])2\|Y]$
$\sigma(X)$, Std(X)	**Standard deviation** of random variable X	$\sigma(-2X)=\|-2\|\sigma(X)$
Skew$[X]$	**Moment coefficient of skewness** of X	Skew$[X]=E[(X-\mu\sigma)3]$
Kurt$[X]$	**Kurtosis** of random variable X	Kurt$[X]=E[(X-\mu\sigma)4]$
$\mu n(X)$	**nth central moment** of random variable X	$\mu n(X)=E[(X-E[X])n]$
μ~$n(X)$	**nth standardized moment** of random variable X	μ~$n(X)=E[(X-\mu\sigma)n]$

$\sigma(X,Y)$, Cov(X,Y)	**Covariance** of random variables X and Y	Cov(X,Y)= Cov(Y,X)
$\rho(X,Y)$, Corr(X,Y)	**Correlation** of random variables X and Y	$\rho(X,Y)$=Cov$(X,Y)\sigma(X)\sigma(Y)$

Probability-related Functions

Symbol Name	Explanation	Example
$f_X(x)$	**Probability mass function** (pmf) / **probability density function** (pdf)	$P(Y\le2)=\int_{-\infty}^{2} f_Y(y)dy$
R_X	**Support** of random variable X	$R_X=\{x\in R \mid f_X(x)>0\}$
$F_X(x)$	**Cumulative distribution function** (cdf) of random variable X	$F_X(5)=P(X\le5)$
$\overline{F}(x),S(x)$	**Survival function** of random variable X	$S(t)=1-F(t)$
$f(x_1,\ldots,x_n)$	**Joint probability function** of random variables $X_1,\ldots,X_n$	$f(1,2)=P(X=1,Y=2)$
$F(x_1,\ldots,x_n)$	**Joint cumulative distribution function** of random variables $X_1,\ldots,X_n$	$F(x,y)=P(X\le x,Y\le y)$

$MX(t)$	**Moment-generating function** of random variable X	$MX(t)=E[etX]$
$\varphi X(t)$	**Characteristic function** of random variable X	$\varphi X(t)=E[eitX]$
$KX(t)$	**Cumulant-generating function** of random variable X	$KX(t)=\ln(E[etX])$
$L(\theta\|x)$	**Likelihood function** of random variable X with parameter θ	If $X\sim\text{Geo}(p)$, then $L(\theta\|X=3)=P(X=3\|p=\theta)$.

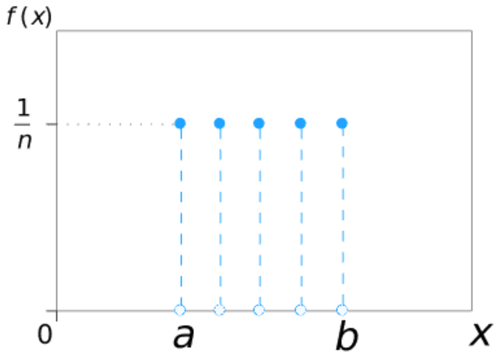
Probability-distribution-related Operators

Discrete Probability Distributions

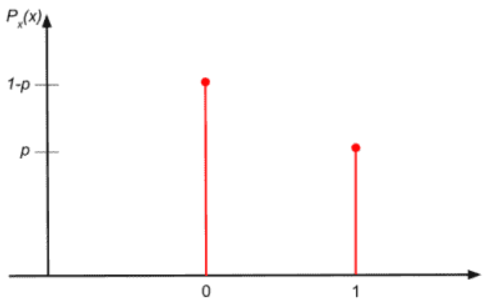
Symbol Name	Explanation	Example
$U\{a,b\}$	Discrete uniform distribu- tion from a to b	Let X be the number on a die following its toss, then $X \sim U\{1,6\}$.
Ber(p)	Bernoulli distribu- tion with p proba- bility of success	If $X \sim$Ber(0.5), then $P(X=0)=$ $P(X=1)=0.5$.
Geo(p)	Geometric distribu- tion with p proba- bility of success	If $X \sim$Geo(p), then $E[X]=1p$.
Bin(n,p)	Binomial distribu- tion with n trials and p probability of success	Let X be the number of heads in a 5-coin toss, then $X \sim$Bin(5,0.5).
NB(r,p)	Negative binomial distribu- tion with r suc- cesses and p prob- ability of success	Let Y be the number of die rolls needed to get the third six, then $Y \sim$NB(3,1/6).

Poisson(λ)	Poisson distribution with rate λ	If X~Poisson(5), then $E[X]=V[X]$ =5.
Hyper(N,K,n)	Hypergeometric distribution with n draws and K favorable items among N	If X~Hyper(N,K,n), then $E[X]=nKN$.

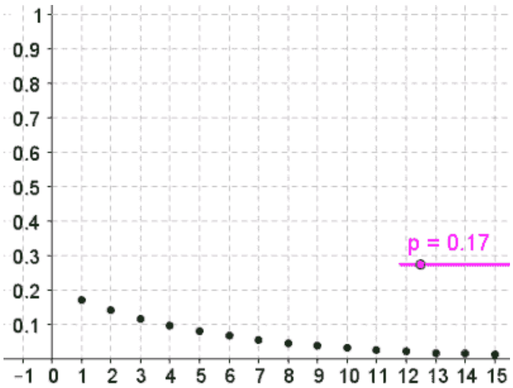
The following graphs illustrate the **probability mass functions** of 6 of the key distributions mentioned above.

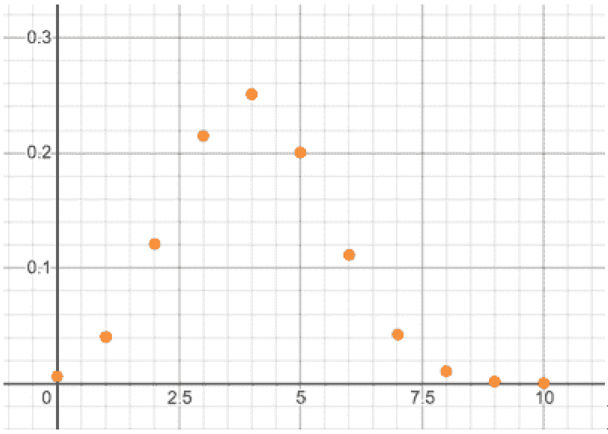
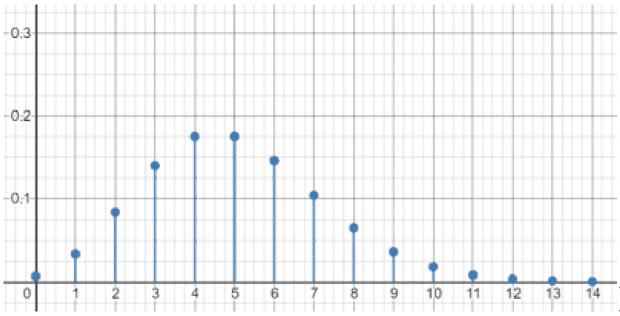
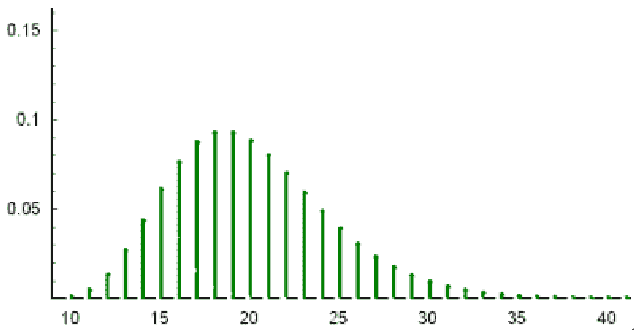
- 

$U\{a,b\}$



Ber(p)

- 

$Geo(0.17)$
- 
$Bin(10{,}0.4)$
- 
$Poisson(5)$
- 
$NB(10{,}0.5)$

Continuous Probability Distributions and Associated Functions

Symbol Name	Explanation	Example
$U(a,b)$	Continuous uniform distribution from a to b	If $X\sim U(5,15)$, then $P(X\leq 6)=110$.
Exp(λ)	Exponential distribution with rate λ	If $Y\sim$Exp(5), then $E[Y]=\sigma[Y]=15$.
$N(\mu,\sigma 2)$	Normal distribution with mean μ and standard deviation σ	If $X\sim N(1,52)$, then $2X+3\sim N(5,102)$.
Z	Standard normal distribution	$Z\sim N(0,1)$
$\varphi(x)$	Pdf of standard normal distribution	$\varphi(x)=12\pi e-x22$
$\Phi(x)$	Cdf of standard normal distribution	$\Phi(z)=P(Z\leq z)$
erf(x)	Error function	erf(x)= $2\pi\int 0xe-t2dt$

z_α	Positive Z-score associated with significance level α	$z_{0.025} \approx 1.96$
$\text{Lognormal}(\mu,\sigma^2)$	Lognormal distribution with parameters μ and σ	If $Y \sim \text{Lognormal}(\mu,\sigma^2)$, then $\ln Y = N(\mu,\sigma^2)$.
$\text{Cauchy}(x_0,\gamma)$	Cauchy distribution with parameters x_0 and γ	If $X \sim \text{Cauchy}(0,1)$, then $f(x)=\frac{1}{\pi(x^2+1)}$.
$\text{Beta}(\alpha,\beta)$	Beta distribution with parameters α and β	If $X \sim \text{Beta}(\alpha,\beta)$, then $f(x) \propto x^{\alpha-1}(1-x)^{\beta-1}$.
$\text{B}(x,y)$	Beta function	$\text{B}(x,y)=\int_0^1 t^{x-1}(1-t)^{y-1}dt$
$\text{Gamma}(\alpha,\beta)$	Gamma distribution with parameters α and β	$\text{Gamma}(1,\lambda)=\text{Exp}(\lambda)$
$\Gamma(x)$	Gamma function	For all $n \in N^+$, $\Gamma(n)=(n-1)!$.
$T(\nu)$	T-distribution with degree of freedom ν	$T(n-1)=\frac{\overline{X}-\mu}{S/\sqrt{n}}$

$t_{\alpha,\nu}$	**Positive t-score** with significance level α and degree of freedom ν	$t_{0.05,1000} \approx z_{0.05}$
$\chi^2(\nu)$	**Chi-squared distribution** with degree of freedom ν	$Z_1^2+\cdots+Z_k^2=\chi^2(k)$
$\chi^2_{\alpha,\nu}$	**Chi-squared score** with significance level α and degree of freedom ν	$\chi^2_{0.05,30}=43.77$
$F(\nu_1,\nu_2)$	**F-distribution** with degrees of freedom ν_1 and ν_2	If $X \sim T(\nu)$, then $X^2 \sim F(1,\nu)$.
F_{α,ν_1,ν_2}	**F-score** with significance level α and degrees of freedom ν_1 and ν_2	$F_{0.05,20,20} \approx 2.1242$

Statistical Operators

Symbol Name	Explanation	Example
X_i, x_i	**I-th value** of data set X	$x_5=9$
$\bar{X}$	**Sample mean** of data set X	$\bar{X}=\frac{\sum X_i}{n}$
$\tilde{X}$	**Median** of data set X	**For a negatively-skewed distribution, $\bar{X} \leq \tilde{X}$.**
Q_i	**I-th quartile**	**Q_3 is also the 75th (empirical) percentile.**
P_i	**I-th percentile**	$P(X \leq P_{95})=0.95$
s_i	**Sample standard deviation** of i-th sample	$s_1>s_2$
σ_i	**Population standard deviation** of i-th sample	**If $\sigma_1=\sigma_2$, then $\sigma_1^2=\sigma_2^2$.**
s^2	**Sample variance**	$s^2=\frac{\sum(X_i-\bar{X})^2}{n-1}$

$sp2$	Pooled sample variance	$sp2$=($n1$−1)$s12$+($n2$−1)$s22n1$+$n2$−2
$\sigma2$	Population variance	If $\sigma12$=$\sigma22$, use pooled variance as a better estimate.
$r2$, $R2$	Coefficient of determination	$R2$=SSregressionSStotal
$\eta2$	Eta-squared (Measure of effect size)	$\eta2$=SStreatmentSStotal
y^	Predicted average value of y in regression	y^0=a+bx0
ε^	Residual in regression	ε^i=yi−y^i
θ^	Estimator of parameter θ	If E(θ^)=θ, then θ^ is an unbiased estimator of θ.
Bias(θ,θ)	Bias of estimator θ^ with respect to parameter θ	Bias(θ,θ)=E[θ^]−θ
$X(k)$	K-th order statistics	X(n)= max{X1,...,Xn}

Relational Symbols

Symbol Name	Explanation	Example
$A \perp B$	Events A and B are independent	If $A \perp B$ and $P(A) \neq 0$, then $P(B \mid A) = P(B)$.
$(A \perp B) \mid C$	Conditional independence (A and B are independent given C)	$(A \perp B) \mid C \Leftrightarrow P(A \cap B \mid C) = P(A \mid C) P(B \mid C)$
$A \nearrow B$	Event A increases the likelihood of event B	If $E1 \nearrow E2$, then $P(E2 \mid E1) \geq P(E2)$.
$A \searrow B$	Event A decreases the likelihood of event B	If $A \searrow B$, then $A \nearrow Bc$.
$X \sim F$	Random variable X follows probability distribution F	If $X1, \ldots, Xn \sim$ Ber(p), then $X1 + \cdots + Xn \sim$ Bin(n,p).

Notational Symbols

Symbol Name	Explanation	Example
IQR	Interquartile range	$IQR=Q3-Q1$
SD	Standard deviation	$2SD=2\cdot 1.5=3$
CV	Coefficient of variation	$CV=\sigma\mu$
SE	Standard error	A statistic of 5.66 corresponds to $10SE$ away from the mean.
SS	Sum of squares	$SSy=\sum(Yi-Y—)2$
MSE	Mean square error	For linear regression, $MSE=\sum(Yi-Y\hat{}i)2n-2$.
OR	Odds ratio	Let $p1$ and $p2$ be the rates of accidents in two regions, then $OR=p1/(1-p1)p2/(1-p2)$.
$H0$	Null hypothesis	$H0:\sigma12=\sigma22$

Ha	Alternative hypothesis	Ha:ρ>0
CI	Confidence interval	95%CI=(0.85,0.97)
PI	Prediction interval	90%PI is wider than 90%CI, as it predicts an instance of y rather than its average.
r.v.	Random variable	A r. v. is continuous if its support consists of a union of disjoint intervals.
i.i.d.	Independent and identically distributed random variables	If $X1$,...,Xn are i.i.d. with $V[Xi]$=$\sigma 2$, then $V[X—]$=$\sigma 2n$.
LLN	Law of large numbers	LLN shows that for all ε>0, as n→∞, $P(\|X—n-\mu\|>\varepsilon)$→0.
CLT	Central limit theorem	By CLT, as n→∞, $X—n-\mu\sigma/n$→Z.