Distribución	Notación	$p_X(x)$	Soporte	Parámetros	$\mathbf{E}[X]$	$\mathbf{var}(X)$
Bernoulli	$\mathrm{Ber}(p)$	$p^x(1-p)^{1-x}$	$\{0,1\}$	$p \in (0,1)$	p	$p(1-p)$
Binomial	$\mathcal{B}(n,p)$	$\binom{n}{x}p^x(1-p)^{n-x}$	$[\![0,n]\!]$	$p \in (0,1),\ n \in \mathbb{N}$	np	$np(1-p)$
Geométrica	$\mathcal{G}(p)$	$(1-p)^{x-1}p$	$\mathbb{N}$	$p \in (0,1)$	$1/p$	$(1-p)/p^2$
Pascal	$\mathrm{Pas}(k,p)$	$\binom{x-1}{k-1}(1-p)^{x-k}p^k$	$\mathbb{Z}_k$	$p \in (0,1),\ k \in \mathbb{N}$	k/p	$k(1-p)/p^2$
Poisson	$\mathrm{Poi}(\mu)$	$(\mu^x e^{-\mu})/x!$	$\mathbb{Z}_0$	$\mu > 0$	μ	μ
Hipergeométrica	$\mathcal{H}(N,d,n)$	$\frac{\binom{d}{x}\binom{N-d}{n-x}}{\binom{N}{n}}$	$[\![m,M]\!]^\dagger$	$d \le N,\ n \le N \in \mathbb{N}$	$\frac{nd}{N}$	$\frac{nd(N-d)(N-n)}{N^2(N-1)}$

Distribución	Notación	$f_X(x)$	Soporte	Parámetros	$\mathbf{E}[X]$	$\mathbf{var}(X)$
Uniforme	$\mathcal{U}[a,b]$	$1/(b-a)$	$[a,b]$	$a < b$	$(a+b)/2$	$(b-a)^2/12$
Exponencial	$\mathcal{E}(\lambda)$	$\lambda e^{-\lambda x}$	$[0,+\infty)$	$\lambda > 0$	$1/\lambda$	$1/\lambda^2$
Gamma	$\Gamma(\nu,\lambda)$	$\frac{\lambda^\nu}{\Gamma(\nu)}x^{\nu-1}e^{-\lambda x}$	$[0,+\infty)$	$\nu > 0, \lambda > 0$	ν/λ	ν/λ^2
Normal	$\mathcal{N}(\mu,\sigma^2)$	$\frac{1}{\sqrt{2\pi}\sigma}e^{\frac{-(x-\mu)^2}{2\sigma^2}}$	$\mathbb{R}$	$\mu \in \mathbb{R}, \sigma^2 > 0$	μ	σ^2
Chi cuadrado	χ^2_k	$\frac{1}{2^{\frac{k}{2}}\Gamma(\frac{k}{2})}x^{\frac{k}{2}-1}e^{-\frac{x}{2}}$	$[0,+\infty)$	$k \in \mathbb{N}$	k	$2k$
t-Student	t_ν	$\frac{\Gamma(\frac{\nu+1}{2})}{\sqrt{\nu\pi}\Gamma(\frac{\nu}{2})}\left(1+\frac{t^2}{\nu}\right)^{-\frac{\nu+1}{2}}$	$\mathbb{R}$	$\nu > 0$	0	$\frac{\nu}{\nu-2}*$
Weibull	$\mathrm{Wei}(c,\alpha)$	$\frac{c}{\alpha}(\frac{x}{\alpha})^{c-1}e^{-(\frac{x}{\alpha})^c}$	$[0,+\infty)$	$c > 0, \alpha > 0$	$\alpha\Gamma(1+\frac{1}{c})$	$\alpha^2\left[\Gamma(1+\frac{2}{c}) -\Gamma^2(1+\frac{1}{c})\right]$
Rayleigh	$\mathrm{Ray}(\sigma)$	$\frac{x}{\sigma^2}e^{-x^2/(2\sigma^2)}$	$[0,+\infty)$	$\sigma > 0$	$\sigma\sqrt{\pi/2}$	$\frac{4-\pi}{2}\sigma^2$
Pareto	$\mathrm{Par}(m,\alpha)$	$\frac{\alpha m^\alpha}{x^{\alpha+1}}$	$[m,+\infty)$	$m > 0, \alpha > 0$	$\frac{\alpha m}{\alpha-1}\,\dagger$	$\frac{m^2\alpha}{(\alpha-1)^2(\alpha-2)}\,\ddagger$
Beta	$\beta(a,b)$	$\frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)}x^{a-1}(1-x)^{b-1}$	$(0,1)$	$a > 0, b > 0$	$a/(a+b)$	$\frac{ab}{(a+b)^2(a+b+1)}$
Cauchy	$\mathrm{Cau}(x_0,\gamma)$	$\frac{1}{\pi\gamma}\left[\frac{\gamma^2}{(x-x_0)^2+\gamma^2}\right]$	$\mathbb{R}$	$x_0 \in \mathbb{R}, \gamma > 0$	no existe	no existe

Condicional: $\mathbb{P}(A|B) = \dfrac{\mathbb{P}(A\cap B)}{\mathbb{P}(A)}$

A, B indep $\rightarrow \mathbb{P}(A|B) = \mathbb{P}(A)$; $\mathbb{P}(A\cap B) = \mathbb{P}(A)\mathbb{P}(B)$

A,B indep

Bayes: $\mathbb{P}(A|B) = \dfrac{\mathbb{P}(B|A)\,\mathbb{P}(A)}{\mathbb{P}(B)}$

Generalización de VA cont. y discreta:

$$f_X(x) = \sum_{y \in \mathcal{X}} p_X(y)\,\delta(x-y)$$

$f_{A,B}(a,b) = f_A \cdot f_B$

$F_{A,B}(a,b) = F_A \cdot F_B$

$$\mathbb{P}(B) = \sum_{i=1}^{n}\mathbb{P}(B\cap A_i) = \sum_{i=1}^{n}\mathbb{P}(B|A_i)\,\mathbb{P}(A_i)$$

$$f_{X|Y}(x|y) = \frac{f_{X,Y}(x,y)}{f_Y(y)}$$

Sea $Y = \sum X_i$ suma de VA indep

$f_Y(y) = f_{X_1} * f_{X_2} * \ldots f_{X_n}$

convolución

$$f_{X_n}(x) = \frac{\partial^n}{\partial x_n}F_{X_n}(x) \longleftarrow F_{X_n}(x) = \int_{-\infty}^{x_n} f_{X_n}(x)\,dx_n$$

n

$$E[g(x)] = \int_{-\infty}^{+\infty} g(x)\,f_X(x)\,dx \qquad E[ax+b] = aE[x]+b$$

Media $\rightarrow E[x]$

$$F_{X|A}(x) = \frac{\mathbb{P}(X\le x, A)}{\mathbb{P}(A)}$$

$\mathrm{Var}(x) = \sigma_x^2 = E\left[(x-\mu_x)^2\right]$ $\quad\sigma_x \rightarrow$ desvío estándar

Transformación biyectiva y suave

f marginal: $f_{X_1}(x) = \int f_{\vec{X}}(\vec{x})\,dx_{2,3\ldots}$

n veces

los que saco

$$f_{\vec{Y}}(\vec{y}) = \frac{f_{\vec{X}}(\vec{x})}{|\det(J(g))|}$$

$\vec{y} = g(\vec{x}) : \mathbb{R}^n \rightarrow \mathbb{R}^n$

$g^{-1}(\vec{y}) = \vec{x}$ $\quad\leftarrow$ Evalúo en la inversa

módulo del determinante del Jacobiano

$$J_x = \begin{vmatrix} \frac{\partial g_1}{\partial x_1} & \cdots & \frac{\partial g_1}{\partial x_n} \\ \vdots & \ddots & \\ \frac{\partial g_n}{\partial x_1} & \cdots & \frac{\partial g_n}{\partial x_n} \end{vmatrix}$$

Señal	$\mathcal{L}$	Roc
$\delta(t)$	1	$\mathbb{C}$
$u(t)$	$\frac{1}{s}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} > 0\}$
$-u(-t)$	$\frac{1}{s}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} < 0\}$
$\frac{t^{n-1}}{(n-1)!}u(t)$	$\frac{1}{s^n}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} < 0\}$
$e^{-\alpha t}u(t)$	$\frac{1}{s+\alpha}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} > -\mathrm{Re}\{\alpha\}\}$
$-e^{-\alpha t}u(-t)$	$\frac{1}{s+\alpha}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} < -\mathrm{Re}\{\alpha\}\}$
$\frac{t^{n-1}}{(n-1)!}e^{-\alpha t}u(t)$	$\frac{1}{(s+\alpha)^n}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} > -\mathrm{Re}\{\alpha\}\}$
$-\frac{t^{n-1}}{(n-1)!}e^{-\alpha t}u(-t)$	$\frac{1}{(s+\alpha)^n}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} < -\mathrm{Re}\{\alpha\}\}$
$\sin(\omega_0 t)u(t)$	$\frac{\omega_0}{s^2+\omega_0^2}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} > 0\}$
$\cos(\omega_0 t)u(t)$	$\frac{s}{s^2+\omega_0^2}$	$\{s \in \mathbb{C} : \mathrm{Re}\{s\} > 0\}$

Desplazamiento Laplace

$$x(t-t_0) \xleftrightarrow{\mathcal{L}} e^{-st_0}X(s),\ \mathrm{ROC}\{e^{-st_0}X(s)\} = \mathrm{ROC}\{X(s)\}$$

$$x(t)e^{s_0 t} \xleftrightarrow{\mathcal{L}} X(s-s_0),\ \mathrm{ROC}\{X(s-s_0)\} = \mathrm{ROC}\{X(s)\} + \mathrm{Re}\{s_0\}$$

$$\mathcal{F}\left[\frac{dx(t)}{dt}\right] = j\omega X(j\omega) \qquad \mathcal{F}\left[\int_{-\infty}^{t} x(\tau)d\tau\right] = \frac{X(j\omega)}{j\omega}$$

$$\int_{-\infty}^{t} x(\tau)d\tau \xleftrightarrow{\mathcal{L}} \frac{X(s)}{s},\ \mathrm{ROC}\left\{\frac{X(s)}{s}\right\} \supseteq \mathrm{ROC}\{X(s)\} \cap \{s \in \mathbb{C} : \mathrm{Re}\{s\} > 0\}$$

$$\frac{dx(t)}{dt} \xleftrightarrow{\mathcal{L}} sX(s),\ \mathrm{ROC}\{sX(s)\} \supseteq \mathrm{ROC}\{X(s)\}$$

$$e^{-\alpha t}\sin(\omega t) \xrightarrow{\mathrm{L}} \frac{\omega}{(s+\alpha)^2+\omega^2}$$

$$e^{-\alpha t}\cos(\omega t) \xrightarrow{\mathrm{L}} \frac{s+\alpha}{(s+\alpha)^2+\omega^2}$$

Serie geométrica:

$$\sum_{n=0}^{\infty} \alpha^n = \frac{1}{1-\alpha}, \quad \alpha \in \mathbb{C},\ |\alpha| < 1$$

Suma geométrica parcial:

$$\sum_{n=N_1}^{N_2-1} \alpha^n = \frac{\alpha^{N_1} - \alpha^{N_2}}{1-\alpha}, \quad \alpha \in \mathbb{C},\ N_1, N_2 \in \mathbb{N}$$

- **Teoremas del valor inicial y final:** Sea $x(t)$ una señal que vale cero para $t < 0$ y que no tiene impulsos de ningún orden en el origen. Entonces valen los siguientes resultados:

$$x(0+) = \lim_{s\to\infty} sX(s)$$

Si $\lim_{t\to\infty} x(t)$ existe:

$$\lim_{t\to\infty} x(t) = \lim_{s\to 0} sX(s)$$

Convolución $x(t) * y(t) = \int_{-\infty}^{\infty} x(\tau)y(t-\tau)d\tau$ $\qquad x[n] * y[n] = \sum_{k=-\infty}^{\infty} x[k]y[n-k]$

Lineal: $T[\alpha x(t) + b y(t)] = a T[x(t)] + b T[y(t)]$

Ti: $T[x(t-t_0)] = y(t-t_0)$

Memoria $\rightarrow h(t) = k\delta(t)$

Causal $\rightarrow h(t) = 0 \ \forall t < 0$

Estable $\rightarrow$ RoC o $\int |h(t)| < \infty$

Ec dif: $\sum_{k=0}^{N} a_k \frac{d^k y(t)}{dt^k} = \sum_{k=0}^{M} b_k \frac{d^k x(t)}{dt^k}$

Nyquist $f_{sample} > 2 f_{max}$

$\mathcal{F}\{x[n-n_0]\} = e^{-j\Omega n_0} X(\Omega)$

$\mathcal{F}\{x(t-t_0)\} = e^{-j\omega t_0} X(\omega)$

$$\sum_{p=0}^{N} y[n-p]\alpha_p = \sum_{q=0}^{M} x[n-q]\beta_q$$

Relación entre transformadas

Z		Ω		DFT
$X(z)$	$\xrightarrow[z=e^{j\Omega}]{}$	$X(\Omega)$	$\xrightarrow[\Omega=\frac{2\pi k}{N}]{}$	$X[k]$

	$\mathcal{F}$	$\mathcal{F}^{-1}$
cont	$X(j\omega) = \int_{-\infty}^{\infty} x(t)e^{-j\omega t}dt,\ \omega \in \mathbb{R}$	$x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(j\omega)e^{j\omega t}d\omega,\ t \in \mathbb{R}$
dis	$X(e^{j\Omega}) = \sum_{n=-\infty}^{\infty} x[n]e^{-j\Omega n},\ \omega \in [-\pi, \pi)$	$x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{j\Omega})e^{j\Omega n}d\omega,\ n \in \mathbb{Z}$

Periódica en 2π

$$H(z) = \frac{\sum_{q=0}^{M} z^{-q}\beta_q}{\sum_{p=0}^{N} z^{-p}\alpha_p} = \frac{\beta_0 + \beta_1 z^{-1} + \dots + \beta_n z^{-n}}{\alpha_1 + \alpha_2 z^{-1} + \dots + \alpha_n z^{-n}}$$

ceros

polos

Señal	Transformada Z	ROC
$\delta[n]$	1	$\mathbb{C}$
$u[n]$	$\frac{1}{1-z^{-1}}$	$\{z \in \mathbb{C} : \lvert z\rvert > 1\}$
$-u[-n-1]$	$\frac{1}{1-z^{-1}}$	$\{z \in \mathbb{C} : \lvert z\rvert < 1\}$
$\alpha^n u[n]$	$\frac{1}{1-\alpha z^{-1}}$	$\{z \in \mathbb{C} : \lvert z\rvert > \lvert\alpha\rvert\}$
$-\alpha^n u[-n-1]$	$\frac{1}{1-\alpha z^{-1}}$	$\{z \in \mathbb{C} : \lvert z\rvert < \lvert\alpha\rvert\}$
$n\alpha^n u[n]$	$\frac{\alpha z^{-1}}{(1-\alpha z^{-1})^2}$	$\{z \in \mathbb{C} : \lvert z\rvert > \lvert\alpha\rvert\}$
$-n\alpha^n u[-n-1]$	$\frac{\alpha z^{-1}}{(1-\alpha z^{-1})^2}$	$\{z \in \mathbb{C} : \lvert z\rvert < \lvert\alpha\rvert\}$
$r^n\cos(\omega_0 n)u[n],\ r>0$	$\frac{1-r\cos(\omega_0)z^{-1}}{1-2r\cos(\omega_0)z^{-1}+r^2z^{-2}}$	$\{z \in \mathbb{C} : \lvert z\rvert > r\}$
$r^n\sin(\omega_0 n)u[n],\ r>0$	$\frac{r\sin(\omega_0)z^{-1}}{1-2r\cos(\omega_0)z^{-1}+r^2z^{-2}}$	$\{z \in \mathbb{C} : \lvert z\rvert > r\}$

$$x[n-n_0] \xleftrightarrow{\mathcal{Z}} z^{-n_0}X(z) \qquad nx[n] \xleftrightarrow{\mathcal{Z}} -z\frac{dX(z)}{dz}$$

Señal	Transformada de Fourier	Serie de Fourier
$\delta(t)$	1	
$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$	$a_1=1$ $a_k=0 \quad \forall k\neq 1$
$\cos(\omega_0 t)$	$\pi\left[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)\right]$	$a_1=a_{-1}=\frac{1}{2}$ $a_k=0 \quad \forall k\neq 1$
$\sin(\omega_0 t)$	$\frac{\pi}{j}\left[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)\right]$	$a_1=-a_{-1}=\frac{1}{2j}$ $a_k=0 \quad \forall k\neq 1$
1	$2\pi\delta(\omega)$	$a_0=1$ $a_k=0 \quad \forall k\neq 0$
$\sum_{n=-\infty}^{\infty}\delta(t-nT)$	$\frac{2\pi}{T}\sum_{n=-\infty}^{\infty}\delta\left(\omega-\frac{2\pi n}{T}\right)$	$a_k=\frac{1}{T}, \quad \forall k$
$\sum_{k=-\infty}^{\infty}a_k e^{jk\omega_0 t}$	$2\pi\sum_{k=-\infty}^{\infty}a_k\delta(\omega-k\omega_0)$	a_k
$u\left(t+T_1\right)-u\left(t-T_1\right)$	$\frac{2\sin(\omega T_1)}{\omega}$	
$x(t)=u\left(t+T_1\right)-u\left(t-T_1\right)$ $x(t+T)=x(t)$	$\sum_{k=-\infty}^{\infty}\frac{2\sin(k\omega_0 T_1)}{k}\delta(\omega-k\omega_0)$	$\frac{\sin(k\omega_0 T_1)}{k\pi}$
$\frac{\sin(Wt)}{\pi t}$	$u\left(\omega+W\right)-u\left(\omega-W\right)$	
$u(t)$	$\frac{1}{j\omega}+\pi\delta(\omega)$	
$e^{-\alpha t}u(t), \mathrm{Re}(\alpha)>0$	$\frac{1}{\alpha+j\omega}$	
$\frac{t^{n-1}}{(n-1)!}e^{-\alpha t}u(t), \mathrm{Re}(\alpha)>0$	$\frac{1}{(\alpha+j\omega)^n}$	
$\frac{1}{\sqrt{2\pi}\sigma}e^{-\frac{t^2}{2\sigma^2}}$	$e^{-\frac{\omega^2\sigma^2}{2}}$	

Señal	Transformada de Fourier	Coeficientes de la serie de Fourier
$\delta[n]$	1	
$e^{j\omega_0 n}$	$2\pi\sum_{l=-\infty}^{\infty}\delta(\omega-\omega_0-2\pi l)$	Si $w_0=\frac{2\pi m}{N}$ $a_k=\begin{cases}1 & k=m, m\pm N, m\pm 2N,\dots \\ 0 & en\ otro\ caso\end{cases}$
$\cos(\omega_0 n)$	$\pi\sum_{l=-\infty}^{\infty}[\delta(\omega-\omega_0-2\pi l)$ $+\delta(\omega+\omega_0-2\pi l)]$	Si $w_0=\frac{2\pi m}{N}$ $a_k=\begin{cases}\frac{1}{2} & k=\pm m, \pm m\pm N, \pm m\pm 2N,\dots \\ 0 & en\ otro\ caso\end{cases}$
$\sin(\omega_0 n)$	$\frac{\pi}{j}\sum_{l=-\infty}^{\infty}[\delta(\omega-\omega_0-2\pi l)$ $-\delta(\omega+\omega_0-2\pi l)]$	Si $w_0=\frac{2\pi m}{N}$ $a_k=\begin{cases}\frac{1}{2j} & k=m, m\pm N, m\pm 2N,\dots \\ -\frac{1}{2j} & k=-m, -m\pm N, -m\pm 2N,\dots \\ 0 & en\ otro\ caso\end{cases}$
1	$2\pi\sum_{l=-\infty}^{\infty}\delta(\omega-2\pi l)$	$a_k=\begin{cases}1 & k=0, \pm N, \pm 2N,\dots \\ 0 & en\ otro\ caso\end{cases}$
$\sum_{k=-\infty}^{\infty}\delta[n-kN]$	$\frac{2\pi}{N}\sum_{k=-\infty}^{\infty}\delta\left(\omega-\frac{2\pi k}{N}\right)$	$a_k=\frac{1}{N} \quad \forall k$
$\sum_{k=\langle N\rangle}a_k e^{j\frac{2\pi k}{N}n}$	$2\pi\sum_{k=-\infty}^{\infty}a_k\delta(\omega-\frac{2\pi k}{N})$	a_k
$u\left[n\right]-u\left[n-N\right]$	$e^{-j\omega\frac{(N-1)}{2}}\frac{\sin(\omega N/2)}{\sin(\omega/2)}$ periódica con periodo 2π	
$x[n]=u\left[n+N_1\right]-u\left[n-N_1-1\right]$ $x[n]=x[n+N]$	$2\pi\sum_{k=-\infty}^{\infty}\delta\left(\omega-\frac{2\pi k}{N}\right)$	$a_k=\frac{\sin\left(\frac{2\pi k}{N}\left(N_1+\frac{1}{2}\right)\right)}{N\sin(\frac{2\pi k}{2N})} \quad k\neq 0, \pm N, \pm 2N,\dots$ $a_k=\frac{2N_1+}{N} \quad k=0, \pm N, \pm 2N,\dots$
$\frac{\sin(Wn)}{\pi n}, \ 0<W<\pi$	$u\left(\omega+W\right)-u\left(\omega-W\right)$ periódica con periodo 2π	
$u[n]$	$\frac{1}{1-e^{-j\omega}}+\pi\delta(\omega)$ periódica con periodo 2π	
$\alpha^n u[n], \lvert\alpha\rvert<1$	$\frac{1}{1-\alpha e^{-j\omega}}$ periódica con periodo 2π	
$\frac{(n+r-1)!}{n!(r-1)!}\alpha^n u[n], \lvert\alpha\rvert<1$	$\frac{1}{(1-\alpha e^{-j\omega})^r}$ periódica con periodo 2π	