USAC
FACULTAD DE INGENIERÍA
ÁREA DE ESTADÍSTICA

FORMULARIO DEL CURSO
ANÁLISIS PROBABILÍSTICO

1. Cadenas de Markov

$P(X_{t+1} = j / X_t = i) = p_{ij}$

Probabilidades de transición en la n-ésima etapa

$P_{ij}(1) = p_{ij}$

$P_{ij}(2) = \sum_{k=1}^{k=s} p_{ik} p_{kj}$

$P_{ij}(n) = ij - \text{ésimo elemento de } P^n$

$$P_{ij}(0) = \begin{cases} 1 \text{ si } j = i \\ 0 \text{ si } j \neq i \end{cases}$$

Probabilidad de estar en el estado j en el tiempo n $= \sum_{i=1}^{i=s} q_i p_{ij}(n)$

Probabilidades de estado estable y tiempos promedio de primer paso.

$P_{ij}(n+1) \cong P_{ij}(n) \cong \pi_j$

$P_{ij}(n+1) = \sum_{k=1}^{k=s} P_{ik}(n) p_{kj}$

$\pi_j = \sum_{k=1}^{k=s} \pi_k p_{kj}$

$\pi = \pi P$

$P_{i1}(n) + P_{i2}(n) + \cdots + P_{is}(n) = 1$

$\pi_1 + \pi_2 + \cdots + \pi_s = 1$

$\pi_j (1 - p_{jj}) = \sum_{k \neq j} \pi_k p_{kj}$

$m_{ij} = 1 + \sum_{k \neq j} p_{ik} m_{kj}$

$m_{ii} = \frac{1}{\pi_i}$

Censo de estado estable

$$H_i + \sum_{k \neq i} N_k p_{ki} = N_i \cdot \sum_{k \neq i} p_{ik} \quad (i = 1, 2, \cdots, s)$$

Cadenas de Marcov de tiempo continuo.

Ecuaciones de balance.

$$\pi_j q_i = \sum_{i \neq j} \pi_i q_{ij} \quad (\text{para } j = 0, 1, \cdots, M)$$

$$\sum_{j=0}^{M} \pi_j = 1$$

2. Teoría de Colas

Modelo M/M/1

$$P_0 = 1 - \frac{\lambda}{\mu}$$

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$L = L_q + \frac{\lambda}{\mu}$$

$$W_q = \frac{L_q}{\lambda}$$

$$W = W_q + \frac{1}{\mu}$$

$$P_w = \frac{\lambda}{\mu}$$

$$P_n = \left(\frac{\lambda}{\mu}\right)^n P_0$$

$$P(W_q^0 > t) = \frac{\lambda}{\mu} e^{-\mu \cdot t\left(1 - \frac{\lambda}{\mu}\right)}$$

$$P(W^0 > t) = e^{-\mu \cdot t\left(1 - \frac{\lambda}{\mu}\right)}$$

Modelo M/M/k

$$P_0 = \frac{1}{\sum_{n=0}^{k-1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^k}{k!}\left(\frac{k\mu}{k\mu-\lambda}\right)}$$

$$L_q = \frac{(\lambda/\mu)^k \lambda\mu}{(k-1)!(k\mu-\lambda)^2} \cdot P_0$$

$$L = L_q + \frac{\lambda}{\mu}$$

$$W_q = \frac{L_q}{\lambda}$$

$$W = W_q + \frac{1}{\mu}$$

$$P_w = \frac{1}{k!} \cdot \left(\frac{\lambda}{\mu}\right)^k \cdot \left(\frac{k\mu}{k\mu-\lambda}\right) \cdot P_0$$

$$P_n = \frac{(\lambda/\mu)^n}{n!} \cdot P_0 \qquad \text{para} \quad n \le k$$

$$P_n = \frac{(\lambda/\mu)^n}{k! k^{(n-k)}} \cdot P_0 \qquad \text{para} \quad n > k$$

$$P(W_q^0 > t) = \left[1 - P(W_q^0 = 0)\right] \cdot e^{-k\cdot\mu\cdot t\left(1-\frac{\lambda}{k\mu}\right)}$$

$$P(W_q^0 = 0) = \sum_{n=0}^{k-1} P_n$$

$$P(W > t) = e^{-\mu\cdot t}\left\{1 + \frac{(\lambda/\mu)^k \cdot P_0 \cdot \left[1 - e^{-\mu\cdot t\left(k-1-\frac{\lambda}{\mu}\right)}\right]}{k!\left(1-\frac{\lambda}{k\mu}\right)\left(k-1-\frac{\lambda}{\mu}\right)}\right\}$$

Modelo M/M/1 población finita

$$\mathbf{P_o} = \frac{\mathbf{1}}{\sum_{\mathbf{n=0}}^{\mathbf{N}} \frac{\mathbf{N!}}{\mathbf{(N-n)!}} \left(\frac{\boldsymbol{\lambda}}{\boldsymbol{\mu}}\right)^{\mathbf{n}}}$$

$$L_q = N - \frac{\lambda + \mu}{\lambda}(1 - P_0)$$

$$L = L_q + (1 - P_0)$$

$$W_q = \frac{L_q}{(N - L)\lambda}$$

$$W = W_q + \frac{1}{\mu}$$

$$P_w = 1 - P_0$$

$$P_n = \frac{N!}{(N-n)!}\left(\frac{\lambda}{\mu}\right)^n P_o \quad \text{para } n = 0, 1, \ldots, N$$

Modelo M/G/1

$$P_o = 1 - \frac{\lambda}{\mu}$$

$$L_q = \frac{\lambda^2\sigma^2 + (\lambda/\mu)^2}{2(1 - \lambda/\mu)}$$

$$L = L_q + \frac{\lambda}{\mu}$$

$$W_q = \frac{L_q}{\lambda}$$

$$W = W_q + \frac{1}{\mu}$$

$$P_W = \frac{\lambda}{\mu}$$

Modelo M/G/k

$$P_j = \frac{(\lambda/\mu)^j / j!}{\sum_{i=0}^{k} (\lambda/\mu)^i / i!}$$

$$L = \frac{\lambda}{\mu}(1 - P_k)$$

Costo total para todos los modelos

$$Ct = c_W L + c_s k$$

3. Distribuciones muestrales

Media

$$Z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}}$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n}} \; ; \; V = \text{n-1}$$

Proporción

$$Z = \frac{\bar{p} - P}{\sigma_{\bar{p}}}$$

$$\sigma_{\bar{p}} = \sqrt{P(1-P)/n}$$

Varianza

$$\chi^2 = \frac{(n-1)S^2}{\sigma^2}; \; V = \text{n-1}$$

4. Estimación

Media:
(con varianza conocida) $\bar{X} \pm \frac{Z_{\alpha/2}\sigma}{\sqrt{n}}$ $E = \frac{Z_{\alpha/2}\sigma}{\sqrt{n}}$

Media:
(con varianza desconocida) $\bar{X} \pm \frac{t_{\alpha/2}s}{\sqrt{n}}$ $E = \frac{t_{\alpha/2}s}{\sqrt{n}}$ V=n-1 grados de libertad

Proporción: $\bar{p} \pm Z_{\alpha/2}\sqrt{\bar{p}(1-\bar{p})/n}$ $E = Z_{\alpha/2}\sqrt{\bar{p}(1-\bar{p})/n}$

Varianza: $\frac{(n-1)s^2}{\chi^2_{\alpha/2}} \leq \sigma^2 \leq \frac{(n-1)s^2}{\chi^2_{1-\alpha/2}}$ *V* = n-1 grados de libertad

5. PRUEBA DE HIPÓTESIS:

Caso	Hipótesis nula	estadístico de prueba
Media con σ^2 conocida	$\mu=\mu_o$	$z = \frac{\bar{x} - \mu_o}{\sigma / \sqrt{n}}$
Media con σ^2 desconocida	$\mu=\mu_o$	$t = \frac{\bar{x} - \mu_o}{s / \sqrt{n}}$ V= n-1
Proporción	$P = P_o$	$Z = \frac{\bar{p} - P_o}{\sqrt{P_o(1-P_o)/n}}$
Varianza	$\sigma^2 = \sigma^2_o$	$\chi^2_o = \frac{(n-1)s^2}{\sigma^2_o}$ *V* = n - 1

Tamaño de muestra

Para media:

A) Ho μ=μo, H1 μ>μo; μ=μo + Ω,

$$n = \frac{(Z_\alpha + Z_\beta)^2 \sigma^2}{\delta^2}$$

B) Ho μ=μo, H1 μ≠μo μo; μ=μo + Ω

$$n = \frac{(Z_{\alpha/2} + Z_\beta)^2 \sigma^2}{\delta^2}$$

Para proporción:

Ho P=Po
H1 P>Po; P=P1

$$n = \left(\frac{Z_\alpha \sqrt{P_o(1-P_o)} + Z_\beta \sqrt{P_1(1-P_1)}}{P_1 - P_o} \right)^2$$

6 Regresión y correlación lineal

$\mu(Y) = \beta_0 + \beta_1 X_1 + ... + \beta_k X_k$, con *n* observaciones

$$\hat{\beta} = (X'X)^{-1} X'Y$$

$$S^2 = \frac{SCE}{n - K - 1}$$

$$SCE = Y'Y - \beta'(X'Y)$$

$$V(\hat{\beta}_i) = C_{ij}\sigma^2$$

$$Cov(\hat{\beta}_i, \hat{\beta}_j) = C_{ij}\sigma^2$$

$$\sigma^2 (X'X)^{-1} = \begin{vmatrix} v(\hat{\beta}_0) & Cov(\hat{\beta}_0, \hat{\beta}_1) & .. & Cov(\hat{\beta}_0, \hat{\beta}_K) \\ Cov(\hat{\beta}_1, \hat{\beta}_0) & v(\hat{\beta}_1) & .. & Cov(\hat{\beta}_1, \hat{\beta}_K) \\ . & . & .. & . \\ Cov(\hat{\beta}_K, \hat{\beta}_1) & Cov(\hat{\beta}_K, \hat{\beta}_1) & .. & v(\hat{\beta}_K) \end{vmatrix}$$

Intervalo de confianza para β:

$$\hat{\beta}_i \pm t_{(\alpha/2,n-k-1)}\sqrt{V(\hat{\beta}_i)}$$

Intervalo de confianza para Y(valor medio):

$$\overline{Y} \pm t_{\alpha/2,n-K-1)}S\sqrt{a'(X'X)^{-1}a}$$

Intervalo de confianza para Y (valor individual):

$$\overline{Y} \pm t_{\alpha/2,n-K-1)}S\sqrt{1+a'(X'X)^{-1}a}$$

Prueba de Hipótesis para β:

$$t = \frac{\hat{\beta}_i - \beta_{io}}{\sqrt{V(\hat{\beta}_i)}}$$

Coeficiente de determinación:

$$r^2 = \frac{\hat{\beta}'(X'Y) - n\overline{Y}^2}{Y'Y - n\overline{Y}^2}$$

Coeficiente de correlación:

$$r = \sqrt{r^2}$$

7. Confiabilidad

$$R(t_0) = 1 - F(t = t_0)$$

$$R(t_0) = \exp\left[- \int_0^{t_0} h(x)dx \right]$$

$$h(t) = \frac{-R'(t)}{R(t)} = \frac{f(t)}{R(t)}$$

$$f(t) = h(t) \exp\left[- \int_0^{t_0} h(x)dx \right]$$

$$E(t) = \int_0^{\infty} t \cdot f(t)dt = \int_0^{\infty} R(t)dt$$

Sistemas en serie:

$$R_s(t) = R_1(t) \cdot R_2(t) \cdot R_3(t) \cdots R_n(t) = \prod_{i=1}^{n} R_i(t)$$

Sistemas en paralelo:

$$R_p(t) = 1 - [(1 - R_1(t)) \cdot (1 - R_2(t)) \cdot (1 - R_3(t)) \cdots (1 - R_n(t))] = 1 - (\prod_{i=1}^{n} (1 - R_i(t))$$

Modelo exponencial:

$$h(t) = \lambda$$

$$R(t) = e^{-\lambda t}$$

$$E(t) = \frac{1}{\lambda} = \beta$$

$$f(t) = \lambda e^{-\lambda t}$$

$$P(t > t_0) = e^{-\lambda t_0}$$

$$V(t) = \frac{1}{\lambda^2}$$

Modelo Gamma:

$$f(t) = \frac{\lambda(\lambda t)^{k-1} e^{-\lambda t}}{(k-1)!}$$

$$R(t) = 1 - \frac{\lambda^k}{(k-1)!} \cdot \int_0^t t^{k-1} e^{-\lambda t} dt = \sum_{i=0}^{k-1} \frac{(\lambda t)^i e^{-\lambda t}}{i!}$$

$$h(t) = \frac{\lambda(\lambda t)^{k-1}}{(k-1)! \cdot \sum_{i=0}^{k-1} \frac{(\lambda t)^i}{i!}}$$

$$E(t) = \frac{k}{\lambda}$$

$$V(t) = \frac{k}{\lambda^2}$$

Modelo Weibull :

$$f(t) = \lambda \cdot \alpha \cdot t^{\alpha-1} \cdot e^{\lambda t^{\alpha}}$$

$$R(t) = e^{-\lambda t^{\alpha}}$$

$$F(t) = 1 - e^{-\lambda t^{\alpha}}$$

$$E(t) = \frac{\Gamma\left(\frac{1}{\alpha} + 1\right)}{\lambda^{1/\alpha}}$$

$$V(t) = \frac{\Gamma\left(\frac{2}{\alpha} + 1\right) - \Gamma^2\left(\frac{1}{\alpha} + 1\right)}{\lambda^{2/\alpha}}$$

$$\Gamma(\alpha) = \int_0^{\infty} y^{\alpha-1} e^{-y} dy$$

AREAS BAJO LA CURVA NORMAL

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.50000	0.49601	0.49202	0.48803	0.48405	0.48006	0.47608	0.47210	0.46812	0.46414
-0.1	0.46017	0.45620	0.45224	0.44828	0.44433	0.44038	0.43644	0.43251	0.42858	0.42465
-0.2	0.42074	0.41683	0.41294	0.40905	0.40517	0.40129	0.39743	0.39358	0.38974	0.38591
-0.3	0.38209	0.37828	0.37448	0.37070	0.36693	0.36317	0.35942	0.35569	0.35197	0.34827
-0.4	0.34458	0.34090	0.33724	0.33360	0.32997	0.32636	0.32276	0.31918	0.31561	0.31207
-0.5	0.30854	0.30503	0.30153	0.29806	0.29460	0.29116	0.28774	0.28434	0.28096	0.27760
-0.6	0.27425	0.27093	0.26763	0.26435	0.26109	0.25785	0.25463	0.25143	0.24825	0.24510
-0.7	0.24196	0.23885	0.23576	0.23270	0.22965	0.22663	0.22363	0.22065	0.21770	0.21476
-0.8	0.21186	0.20897	0.20611	0.20327	0.20045	0.19766	0.19489	0.19215	0.18943	0.18673
-0.9	0.18406	0.18141	0.17879	0.17619	0.17361	0.17106	0.16853	0.16602	0.16354	0.16109
-1.0	0.15866	0.15625	0.15386	0.15151	0.14917	0.14686	0.14457	0.14231	0.14007	0.13786
-1.1	0.13567	0.13350	0.13136	0.12924	0.12714	0.12507	0.12302	0.12100	0.11900	0.11702
-1.2	0.11507	0.11314	0.11123	0.10935	0.10749	0.10565	0.10383	0.10204	0.10027	0.09853
-1.3	0.09680	0.09510	0.09342	0.09176	0.09012	0.08851	0.08691	0.08534	0.08379	0.08226
-1.4	0.08076	0.07927	0.07780	0.07636	0.07493	0.07353	0.07215	0.07078	0.06944	0.06811
-1.5	0.06681	0.06552	0.06426	0.06301	0.06178	0.06057	0.05938	0.05821	0.05705	0.05592
-1.6	0.05480	0.05370	0.05262	0.05155	0.05050	0.04947	0.04846	0.04746	0.04648	0.04551
-1.7	0.04457	0.04363	0.04272	0.04182	0.04093	0.04006	0.03920	0.03836	0.03754	0.03673
-1.8	0.03593	0.03515	0.03438	0.03362	0.03288	0.03216	0.03144	0.03074	0.03005	0.02938
-1.9	0.02872	0.02807	0.02743	0.02680	0.02619	0.02559	0.02500	0.02442	0.02385	0.02330
-2.0	0.02275	0.02222	0.02169	0.02118	0.02068	0.02018	0.01970	0.01923	0.01876	0.01831
-2.1	0.01786	0.01743	0.01700	0.01659	0.01618	0.01578	0.01539	0.01500	0.01463	0.01426
-2.2	0.01390	0.01355	0.01321	0.01287	0.01255	0.01222	0.01191	0.01160	0.01130	0.01101
-2.3	0.01072	0.01044	0.01017	0.00990	0.00964	0.00939	0.00914	0.00889	0.00866	0.00842
-2.4	0.00820	0.00798	0.00776	0.00755	0.00734	0.00714	0.00695	0.00676	0.00657	0.00639
-2.5	0.00621	0.00604	0.00587	0.00570	0.00554	0.00539	0.00523	0.00508	0.00494	0.00480
-2.6	0.00466	0.00453	0.00440	0.00427	0.00415	0.00402	0.00391	0.00379	0.00368	0.00357
-2.7	0.00347	0.00336	0.00326	0.00317	0.00307	0.00298	0.00289	0.00280	0.00272	0.00264
-2.8	0.00256	0.00248	0.00240	0.00233	0.00226	0.00219	0.00212	0.00205	0.00199	0.00193
-2.9	0.00187	0.00181	0.00175	0.00169	0.00164	0.00159	0.00154	0.00149	0.00144	0.00139
-3.0	0.00135	0.00131	0.00126	0.00122	0.00118	0.00114	0.00111	0.00107	0.00104	0.00100
-3.1	0.00097	0.00094	0.00090	0.00087	0.00084	0.00082	0.00079	0.00076	0.00074	0.00071
-3.2	0.00069	0.00066	0.00064	0.00062	0.00060	0.00058	0.00056	0.00054	0.00052	0.00050
-3.3	0.00048	0.00047	0.00045	0.00043	0.00042	0.00040	0.00039	0.00038	0.00036	0.00035
-3.4	0.00034	0.00032	0.00031	0.00030	0.00029	0.00028	0.00027	0.00026	0.00025	0.00024
-3.5	0.00023	0.00022	0.00022	0.00021	0.00020	0.00019	0.00019	0.00018	0.00017	0.00017
-3.6	0.00016	0.00015	0.00015	0.00014	0.00014	0.00013	0.00013	0.00012	0.00012	0.00011
-3.7	0.00011	0.00010	0.00010	0.00010	0.00009	0.00009	0.00008	0.00008	0.00008	0.00008
-3.8	0.00007	0.00007	0.00007	0.00006	0.00006	0.00006	0.00006	0.00005	0.00005	0.00005
-3.9	0.00005	0.00005	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004	0.00003	0.00003
-4.0	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00002	0.00002	0.00002	0.00002

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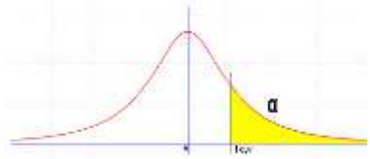
Z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.50000	0.50399	0.50798	0.51197	0.51595	0.51994	0.52392	0.52790	0.53188	0.53586
0.1	0.53983	0.54380	0.54776	0.55172	0.55567	0.55962	0.56356	0.56749	0.57142	0.57535
0.2	0.57926	0.58317	0.58706	0.59095	0.59483	0.59871	0.60257	0.60642	0.61026	0.61409
0.3	0.61791	0.62172	0.62552	0.62930	0.63307	0.63683	0.64058	0.64431	0.64803	0.65173
0.4	0.65542	0.65910	0.66276	0.66640	0.67003	0.67364	0.67724	0.68082	0.68439	0.68793
0.5	0.69146	0.69497	0.69847	0.70194	0.70540	0.70884	0.71226	0.71566	0.71904	0.72240
0.6	0.72575	0.72907	0.73237	0.73565	0.73891	0.74215	0.74537	0.74857	0.75175	0.75490
0.7	0.75804	0.76115	0.76424	0.76730	0.77035	0.77337	0.77637	0.77935	0.78230	0.78524
0.8	0.78814	0.79103	0.79389	0.79673	0.79955	0.80234	0.80511	0.80785	0.81057	0.81327
0.9	0.81594	0.81859	0.82121	0.82381	0.82639	0.82894	0.83147	0.83398	0.83646	0.83891
1.0	0.84134	0.84375	0.84614	0.84849	0.85083	0.85314	0.85543	0.85769	0.85993	0.86214
1.1	0.86433	0.86650	0.86864	0.87076	0.87286	0.87493	0.87698	0.87900	0.88100	0.88298
1.2	0.88493	0.88686	0.88877	0.89065	0.89251	0.89435	0.89617	0.89796	0.89973	0.90147
1.3	0.90320	0.90490	0.90658	0.90824	0.90988	0.91149	0.91309	0.91466	0.91621	0.91774
1.4	0.91924	0.92073	0.92220	0.92364	0.92507	0.92647	0.92785	0.92922	0.93056	0.93189
1.5	0.93319	0.93448	0.93574	0.93699	0.93822	0.93943	0.94062	0.94179	0.94295	0.94408
1.6	0.94520	0.94630	0.94738	0.94845	0.94950	0.95053	0.95154	0.95254	0.95352	0.95449
1.7	0.95543	0.95637	0.95728	0.95818	0.95907	0.95994	0.96080	0.96164	0.96246	0.96327
1.8	0.96407	0.96485	0.96562	0.96638	0.96712	0.96784	0.96856	0.96926	0.96995	0.97062
1.9	0.97128	0.97193	0.97257	0.97320	0.97381	0.97441	0.97500	0.97558	0.97615	0.97670
2.0	0.97725	0.97778	0.97831	0.97882	0.97932	0.97982	0.98030	0.98077	0.98124	0.98169
2.1	0.98214	0.98257	0.98300	0.98341	0.98382	0.98422	0.98461	0.98500	0.98537	0.98574
2.2	0.98610	0.98645	0.98679	0.98713	0.98745	0.98778	0.98809	0.98840	0.98870	0.98899
2.3	0.98928	0.98956	0.98983	0.99010	0.99036	0.99061	0.99086	0.99111	0.99134	0.99158
2.4	0.99180	0.99202	0.99224	0.99245	0.99266	0.99286	0.99305	0.99324	0.99343	0.99361
2.5	0.99379	0.99396	0.99413	0.99430	0.99446	0.99461	0.99477	0.99492	0.99506	0.99520
2.6	0.99534	0.99547	0.99560	0.99573	0.99585	0.99598	0.99609	0.99621	0.99632	0.99643
2.7	0.99653	0.99664	0.99674	0.99683	0.99693	0.99702	0.99711	0.99720	0.99728	0.99736
2.8	0.99744	0.99752	0.99760	0.99767	0.99774	0.99781	0.99788	0.99795	0.99801	0.99807
2.9	0.99813	0.99819	0.99825	0.99831	0.99836	0.99841	0.99846	0.99851	0.99856	0.99861
3.0	0.99865	0.99869	0.99874	0.99878	0.99882	0.99886	0.99889	0.99893	0.99896	0.99900
3.1	0.99903	0.99906	0.99910	0.99913	0.99916	0.99918	0.99921	0.99924	0.99926	0.99929
3.2	0.99931	0.99934	0.99936	0.99938	0.99940	0.99942	0.99944	0.99946	0.99948	0.99950
3.3	0.99952	0.99953	0.99955	0.99957	0.99958	0.99960	0.99961	0.99962	0.99964	0.99965
3.4	0.99966	0.99968	0.99969	0.99970	0.99971	0.99972	0.99973	0.99974	0.99975	0.99976
3.5	0.99977	0.99978	0.99978	0.99979	0.99980	0.99981	0.99981	0.99982	0.99983	0.99983
3.6	0.99984	0.99985	0.99985	0.99986	0.99986	0.99987	0.99987	0.99988	0.99988	0.99989
3.7	0.99989	0.99990	0.99990	0.99990	0.99991	0.99991	0.99992	0.99992	0.99992	0.99992
3.8	0.99993	0.99993	0.99993	0.99994	0.99994	0.99994	0.99994	0.99995	0.99995	0.99995
3.9	0.99995	0.99995	0.99996	0.99996	0.99996	0.99996	0.99996	0.99996	0.99997	0.99997
4.0	0.99997	0.99997	0.99997	0.99997	0.99997	0.99997	0.99998	0.99998	0.99998	0.99998

TABLA T-STUDENT



	α							
v	**0.45**	**0.4**	**0.35**	**0.3**	**0.25**	**0.2**	**0.15**	**0.1**
1	0.15840	0.32490	0.50950	0.72650	1.00000	1.37640	1.96260	3.07770
2	0.14210	0.28870	0.44470	0.61720	0.81650	1.06070	1.38620	1.88560
3	0.13660	0.27670	0.42420	0.58440	0.76490	0.97850	1.24980	1.63770
4	0.13380	0.27070	0.41420	0.56860	0.74070	0.94100	1.18960	1.53320
5	0.13220	0.26720	0.40820	0.55940	0.72670	0.91950	1.15580	1.47590
6	0.13110	0.26480	0.40430	0.55340	0.71760	0.90570	1.13420	1.43980
7	0.13030	0.26320	0.40150	0.54910	0.71110	0.89600	1.11920	1.41490
8	0.12970	0.26190	0.39950	0.54590	0.70640	0.88890	1.10810	1.39680
9	0.12930	0.26100	0.39790	0.54350	0.70270	0.88340	1.09970	1.38300
10	0.12890	0.26020	0.39660	0.54150	0.69980	0.87910	1.09310	1.37220
11	0.12860	0.25960	0.39560	0.53990	0.69740	0.87550	1.08770	1.36340
12	0.12830	0.25900	0.39470	0.53860	0.69550	0.87260	1.08320	1.35620
13	0.12810	0.25860	0.39400	0.53750	0.69380	0.87020	1.07950	1.35020
14	0.12800	0.25820	0.39330	0.53660	0.69240	0.86810	1.07630	1.34500
15	0.12780	0.25790	0.39280	0.53570	0.69120	0.86620	1.07350	1.34060
16	0.12770	0.25760	0.39230	0.53500	0.69010	0.86470	1.07110	1.33680
17	0.12760	0.25730	0.39190	0.53440	0.68920	0.86330	1.06900	1.33340
18	0.12740	0.25710	0.39150	0.53380	0.68840	0.86200	1.06720	1.33040
19	0.12740	0.25690	0.39120	0.53330	0.68760	0.86100	1.06550	1.32770
20	0.12730	0.25670	0.39090	0.53290	0.68700	0.86000	1.06400	1.32530
21	0.12720	0.25660	0.39060	0.53250	0.68640	0.85910	1.06270	1.32320
22	0.12710	0.25640	0.39040	0.53210	0.68580	0.85830	1.06140	1.32120
23	0.12710	0.25630	0.39020	0.53170	0.68530	0.85750	1.06030	1.31950
24	0.12700	0.25620	0.39000	0.53140	0.68480	0.85690	1.05930	1.31780
25	0.12690	0.25610	0.38980	0.53120	0.68440	0.85620	1.05840	1.31630
26	0.12690	0.25600	0.38960	0.53090	0.68400	0.85570	1.05750	1.31500
27	0.12680	0.25590	0.38940	0.53060	0.68370	0.85510	1.05670	1.31370
28	0.12680	0.25580	0.38930	0.53040	0.68340	0.85460	1.05600	1.31250
29	0.12680	0.25570	0.38920	0.53020	0.68300	0.85420	1.05530	1.31140
30	0.12670	0.25560	0.38900	0.53000	0.68280	0.85380	1.05470	1.31040
32	0.12670	0.25550	0.38880	0.52970	0.68220	0.85300	1.05350	1.30860
34	0.12660	0.25530	0.38860	0.52940	0.68180	0.85230	1.05250	1.30700
36	0.12660	0.25520	0.38840	0.52910	0.68140	0.85170	1.05160	1.30550
38	0.12650	0.25510	0.38820	0.52880	0.68100	0.85120	1.05080	1.30420
40	0.12650	0.25500	0.38810	0.52860	0.68070	0.85070	1.05000	1.30310
45	0.12640	0.25490	0.38780	0.52810	0.68000	0.84970	1.04850	1.30070
50	0.12630	0.25470	0.38750	0.52780	0.67940	0.84890	1.04730	1.29870
60	0.12620	0.25450	0.38720	0.52720	0.67860	0.84770	1.04550	1.29580
90	0.12600	0.25410	0.38660	0.52630	0.67720	0.84560	1.04240	1.29100
120	0.12590	0.25390	0.38620	0.52580	0.67650	0.84460	1.04090	1.28860
∞	0.12570	0.25330	0.38530	0.52440	0.67450	0.84160	1.03640	1.28160

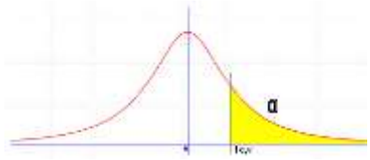


TABLA T-STUDENT

	α							
v	**0.05**	**0.025**	**0.0125**	**0.01**	**0.005**	**0.0025**	**0.001**	**0.0005**
1	6.3137	12.7062	25.4519	31.8210	63.6559	127.3211	318.2888	636.5776
2	2.9200	4.3027	6.2054	6.9645	9.9250	14.0892	22.3285	31.5998
3	2.3534	3.1824	4.1765	4.5407	5.8408	7.4532	10.2143	12.9244
4	2.1318	2.7765	3.4954	3.7469	4.6041	5.5975	7.1729	8.6101
5	2.0150	2.5706	3.1634	3.3649	4.0321	4.7733	5.8935	6.8685
6	1.9432	2.4469	2.9687	3.1427	3.7074	4.3168	5.2075	5.9587
7	1.8946	2.3646	2.8412	2.9979	3.4995	4.0294	4.7853	5.4081
8	1.8595	2.3060	2.7515	2.8965	3.3554	3.8325	4.5008	5.0414
9	1.8331	2.2622	2.6850	2.8214	3.2498	3.6896	4.2969	4.7809
10	1.8125	2.2281	2.6338	2.7638	3.1693	3.5814	4.1437	4.5868
11	1.7959	2.2010	2.5931	2.7181	3.1058	3.4966	4.0248	4.4369
12	1.7823	2.1788	2.5600	2.6810	3.0545	3.4284	3.9296	4.3178
13	1.7709	2.1604	2.5326	2.6503	3.0123	3.3725	3.8520	4.2209
14	1.7613	2.1448	2.5096	2.6245	2.9768	3.3257	3.7874	4.1403
15	1.7531	2.1315	2.4899	2.6025	2.9467	3.2860	3.7329	4.0728
16	1.7459	2.1199	2.4729	2.5835	2.9208	3.2520	3.6861	4.0149
17	1.7396	2.1098	2.4581	2.5669	2.8982	3.2224	3.6458	3.9651
18	1.7341	2.1009	2.4450	2.5524	2.8784	3.1966	3.6105	3.9217
19	1.7291	2.0930	2.4334	2.5395	2.8609	3.1737	3.5793	3.8833
20	1.7247	2.0860	2.4231	2.5280	2.8453	3.1534	3.5518	3.8496
21	1.7207	2.0796	2.4138	2.5176	2.8314	3.1352	3.5271	3.8193
22	1.7171	2.0739	2.4055	2.5083	2.8188	3.1188	3.5050	3.7922
23	1.7139	2.0687	2.3979	2.4999	2.8073	3.1040	3.4850	3.7676
24	1.7109	2.0639	2.3910	2.4922	2.7970	3.0905	3.4668	3.7454
25	1.7081	2.0595	2.3846	2.4851	2.7874	3.0782	3.4502	3.7251
26	1.7056	2.0555	2.3788	2.4786	2.7787	3.0669	3.4350	3.7067
27	1.7033	2.0518	2.3734	2.4727	2.7707	3.0565	3.4210	3.6895
28	1.7011	2.0484	2.3685	2.4671	2.7633	3.0470	3.4082	3.6739
29	1.6991	2.0452	2.3638	2.4620	2.7564	3.0380	3.3963	3.6595
30	1.6973	2.0423	2.3596	2.4573	2.7500	3.0298	3.3852	3.6460
32	1.6939	2.0369	2.3518	2.4487	2.7385	3.0149	3.3653	3.6218
34	1.6909	2.0322	2.3451	2.4411	2.7284	3.0020	3.3480	3.6007
36	1.6883	2.0281	2.3391	2.4345	2.7195	2.9905	3.3326	3.5821
38	1.6860	2.0244	2.3337	2.4286	2.7116	2.9803	3.3190	3.5657
40	1.6839	2.0211	2.3289	2.4233	2.7045	2.9712	3.3069	3.5510
45	1.6794	2.0141	2.3189	2.4121	2.6896	2.9521	3.2815	3.5203
50	1.6759	2.0086	2.3109	2.4033	2.6778	2.9370	3.2614	3.4960
60	1.6706	2.0003	2.2990	2.3901	2.6603	2.9146	3.2317	3.4602
90	1.6620	1.9867	2.2795	2.3685	2.6316	2.8779	3.1832	3.4019
120	1.6576	1.9799	2.2699	2.3578	2.6174	2.8599	3.1595	3.3734
∞	1.6449	1.9600	2.2414	2.3264	2.5758	2.8070	3.0902	3.2905

TABLA CHI-CUADRADO

g.l.	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	---	---	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.070	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.300
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.195	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

Tabla de Números Aleatorios

4751	4847	4249	4648	5047	4847	5156	8789
5046	4756	4738	5350	4746	4847	4846	2346
3583	8997	1533	6466	8830	7271	3809	4256
7880	0586	8482	7811	6807	3309	2729	2235
7600	1077	4455	8806	1822	1669	7501	8330
4092	4223	6454	7632	7577	2816	9002	2365
4846	4647	5034	4646	5139	5355	5249	2224
7236	0812	4195	5589	0830	8261	9232	0902
0377	3590	2209	4839	6332	1490	3092	2390
7203	1231	0546	6612	1038	1425	2709	3092
8974	3961	2183	5295	3096	8536	9442	2392
6307	2346	1285	7000	5306	0414	3383	2303
8843	2112	8567	8131	8116	5270	5994	9092
2192	0874	2897	0262	5092	5541	4014	2113
4247	4859	2660	7852	9096	0578	0097	1324
6612	0721	3899	2999	1263	7017	8057	3443
3464	1702	9204	3389	5678	2589	0288	6343
7551	3380	2152	5411	2647	7242	2800	3432
9691	9562	3252	9848	6030	8472	2266	3255
3167	8552	5409	1556	4247	4652	2953	9854
5457	7703	2758	2963	8167	6712	9820	5324
2315	8030	7651	5189	0075	9353	1921	0222
8204	4143	2677	0034	8601	3340	8383	3243
0390	5579	4620	5650	0210	2082	4664	5643
3485	0741	9069	5920	4326	7704	6525	1249
4141	1521	9104	5563	1392	8238	4882	2324
4612	8252	1062	1757	0964	2983	2244	7654
7423	3298	3979	2831	2257	1508	7642	1245
7171	7720	6509	7549	2330	5733	4730	4534
6858	1489	2669	3743	1901	4971	8280	0835
5933	1137	7583	6450	5658	7678	3444	3754
3753	1859	6043	0294	5110	6340	9137	6323
0163	9717	4118	4276	9465	8820	4127	0202
5101	1815	7068	6379	7252	1086	8919	2093
5068	7447	1664	9278	1708	3625	2864	0204
0074	6677	8676	0222	3335	1976	1645	3203
0255	5458	6942	8043	6201	1587	0972	0243
6333	1931	9433	2661	8690	2313	6999	3094
1815	7171	8036	1832	2031	6298	6073	9044
7765	3194	3222	4191	2734	4469	8617	3233