Universidad Autonoma de Nuevo León

Facultad de Ingenieria Mecánica y Eléctrica

Modelado y simulación de sistemas

Pruebas Estadísticas

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Prueba de Promedios

a)

0.03315	0.01422	0.43031	0.05452	0.71407
0.01189	0.33096	0.90593	0.86316	0.50452

$$\bar{x} = \frac{0.03315 + 0.01422 + 0.43031 + 0.05452 + 0.71407 + 0.01189 + 0.33096 + 0.90593 + 0.86316 + 0.50452}{10}$$

$$\bar{x} = \frac{3.86273}{10} = 0.386273$$

$$Z_0 = \left| \frac{(\bar{x} - \frac{1}{2})\sqrt{10}}{\sqrt{\frac{1}{12}}} \right| = \left| \frac{(0.386273 - \frac{1}{2})\sqrt{10}}{\sqrt{\frac{1}{12}}} \right| = 1.245816$$

$$a_{real} = 100\% - 5\% = 95\% = 0.95$$

$$Z_{area\,1/2} = Z_{0.92/2} = Z_{.475} \qquad Z = 1.96$$

$$\boxed{Z_0 = 1.245816 < Z = 1.96}$$ Los números rectangulares son aceptados.

Prueba de Promedios

b)

| 0.10461 | 0.73709 | 0.68777 | 0.30231 | 0.97599 |
| 0.95554 | 0.52861 | 0.66591 | 0.21704 | 0.63379 |

$$\bar{x} = \frac{0.10461 + 0.73704 + 0.68777 + 0.30231 + 0.97599 + 0.95554 + 0.52861 + 0.66591 + 0.21704 + 0.63379}{10}$$

$$\bar{x} = \frac{5.80861}{10} = 0.580861$$

$$Z_0 = \left| \frac{(\bar{x} - \frac{1}{2})\sqrt{10}}{\sqrt{\frac{1}{12}}} \right| = \left| \frac{(0.580861 - \frac{1}{2})\sqrt{10}}{\sqrt{\frac{1}{12}}} \right| = 0.885787$$

$$a_{real} = 100\% - 5\% = 95\% = 0.95$$

$$Z_{areal/2} = Z_{0.95/2} = Z_{0.475} \qquad Z = 1.96$$

$$\boxed{Z_0 = 0.885787 < Z = 1.96}$$

Los números rectangulares son aceptadas.

Pruebas Estadísticas

Prueba de promedios

Considerando $a = 5\%$.

c)

0.43315	0.31422	0.43031	0.15452	0.71427
0.71189	0.33095	0.912593	0.76316	0.50552

$$\bar{x} = \frac{0.43315 + 0.31422 + 0.43031 + 0.15452 + 0.71427 + 0.71189 + 0.33095 + 0.912593 + 0.76316 + 0.50552}{10}$$

$$\bar{x} = \frac{5.270583}{10} = 0.5270583$$

$$Z_0 = \left| \frac{(\bar{x} - \frac{1}{2})\sqrt{N}}{\sqrt{\frac{1}{12}}} \right| = \left| \frac{(0.5270583 - \frac{1}{2})\sqrt{10}}{\sqrt{\frac{1}{12}}} \right| = 0.296408825$$

$$Z_0 = 0.296408825$$

$$a_{real} = 100\% - 5\% = 95\% = 0.95$$

$$Z_{a_{real}/2} = Z_{0.95/2} = Z_{0.475} \qquad Z = 1.96$$

$$Z_0 < Z \longrightarrow \boxed{0.296408825 < 1.96}$$

Los números rectangulares son aceptados.

Prueba de KS

a)
0.03315	0.01422	0.43031	0.05452	0.71407
0.01189	0.33096	0.90593	0.86316	0.50452

$a = 5\%$.

i	x_i	$F(x_i)$	D_n
1	0.01189	$1/10 = 0.1$	$0.1 - 0.01189 = 0.08811$
2	0.01422	$2/10 = 0.2$	$0.2 - 0.01422 = 0.18578$
3	0.03315	$3/10 = 0.3$	$0.3 - 0.03315 = 0.26685$
4	0.05452	$4/10 = 0.4$	$0.4 - 0.05452 = 0.34548$ ← Valor estadístico mayor
5	0.33096	$5/10 = 0.5$	$0.5 - 0.33096 = 0.16904$
6	0.43031	$6/10 = 0.6$	$0.6 - 0.43031 = 0.16969$
7	0.50452	$7/10 = 0.7$	$0.7 - 0.50452 = 0.19548$
8	0.71407	$8/10 = 0.8$	$0.8 - 0.71407 = 0.08593$
9	0.86316	$9/10 = 0.9$	$0.9 - 0.86316 = 0.03684$
10	0.90593	$10/10 = 1$	$1 - 0.90593 = 0.09407$

$$D_n = 0.34548 \quad < \quad d_{a,N} = d_{0.05,10} = 0.409$$

Los números rectangulares son aceptados.

Prueba de KS

b)
| 0.10461 | 0.73704 | 0.68777 | 0.30231 | 0.97599 |
| 0.95554 | 0.52861 | 0.66591 | 0.21704 | 0.63379 |

$a = 5\%$

i	x_i	$F(x_i)$	D_n	
1	0.10461	$1/10 = 0.1$	$0.1 - 0.10461 = 0.00461$	
2	0.21704	$2/10 = 0.2$	$0.2 - 0.21704 = 0.0174$	
3	0.30231	$3/10 = 0.3$	$0.3 - 0.30231 = 0.00231$	
4	0.52861	$4/10 = 0.4$	$0.4 - 0.52861 = 0.12861$	Valor estadístico mayor
5	0.63379	$5/10 = 0.5$	$0.5 - 0.63379 = 0.13379$ ←	
6	0.66591	$6/10 = 0.6$	$0.6 - 0.66591 = 0.06591$	
7	0.68777	$7/10 = 0.7$	$0.7 - 0.68777 = 0.01223$	
8	0.73704	$8/10 = 0.8$	$0.8 - 0.73704 = 0.06296$	
9	0.95554	$9/10 = 0.9$	$0.9 - 0.95554 = 0.05554$	
10	0.97599	$10/10 = 1$	$1 - 0.97599 = 0.62401$	

$$D_n = 0.13379 \quad < \quad d_{a,N} = d_{0.05,10} = 0.409$$

Los números rectangulares son aceptados.

Prueba de KS

c)
| 0.43315 | 0.31422 | 0.43031 | 0.15452 | 0.71427 |
| 0.71189 | 0.33095 | 0.912593 | 0.76316 | 0.50552 |

$a = 5\%$.

i	X_i	$F(X_i)$	D_n
1	0.15452	$1/10 = 0.1$	$0.1 - 0.15452 = 0.05452$
2	0.31422	$2/10 = 0.2$	$0.2 - 0.31422 = 0.11422$
3	0.33095	$3/10 = 0.3$	$0.3 - 0.33095 = 0.03095$
4	0.43031	$4/10 = 0.4$	$0.4 - 0.43031 = 0.03031$
5	0.43315	$5/10 = 0.5$	$0.5 - 0.43315 = 0.06685$
6	0.50552	$6/10 = 0.6$	$0.6 - 0.50552 = 0.09448$
7	0.71189	$7/10 = 0.7$	$0.7 - 0.71189 = 0.01189$
8	0.71427	$8/10 = 0.8$	$0.8 - 0.71427 = 0.08573$
9	0.76316	$9/10 = 0.9$	$0.9 - 0.76316 = 0.13684$
10	0.912593	$10/10 = 1$	$1 - 0.912593 = 0.087407$

Valor estadístico mayor

$$D_n = 0.13684 < d_{\alpha, N} = d_{0.05, 10} = 0.409$$

Los números rectangulares son aceptados

Prueba de frecuencias

a)
| 0.03315 | 0.01422 | 0.43031 | 0.05452 | 0.71407 |
| 0.01189 | 0.33096 | 0.90593 | 0.86316 | 0.50452 |

$q = 5\%$ $n = 2$ $N = 10$

Intervalos de 2 $FE_i = \dfrac{N}{n} = \dfrac{10}{2} = 5$

$$FE_i \quad \begin{array}{|c|c|c c c} & 5 & & 5 & \\ \end{array}$$

| FE: | 5 | 5 | | | |
| FO: | 2 | 2 | 2 | 2 | 2 |

```
    0              0.5            1
   0/2            1/2           2/2
```

La prueba no aplica debido a que no queda la FO y la FE por lo tanto, los números son rechazados.

Prueba de frecuencias

b) 0.10461   0.73704   0.68777   0.30231   0.97599

0.95554   0.52861   0.66591   0.21704   0.63379

$a = 5\%$ $n = 2$ $N = 10$

Intervalo de 2 $FE_i = \dfrac{N}{n} = \dfrac{10}{2} = 5$

FE:		5		5				
FO.		2		2		2	2	2

0	.05	1.		.8
$^0/_2$	$^1/_2$	$^2/_2$		

La prueba no aplica debido a que no queda la FO, y la FE por lo tanto, los números rectangulares son rechazados.

Prueba de frecuencias

c) 0.43315   0.31422   0.43031   0.15452   0.71427
   0.7189   0.33095   0.912593 0.76316   0.50552

$\alpha = 5\%$ $n = 2$ $N = 10$

Intervalos de 2 $FE_i = \dfrac{N}{n} = \dfrac{10}{2} = 5$

FEᵢ		5		5			

FEᵢ |_____5_____|_____5_____|
FOᵢ | 2 | 2 | 2   2   2

     0   0.5   1
     0/2   1/2   2/2

La prueba no aplica debido a que no queda la FO y la FE
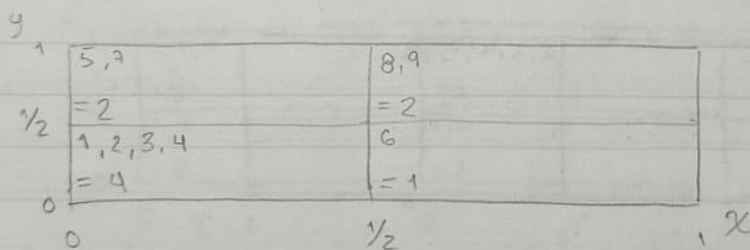por lo tanto, los números rectangulares son rechazados

Prueba de series

a) 0.03315   0.01422   0.43031   0.05452   0.71407

    0.01189   0.33096   0.90593   0.86316   0.50452

$a = 5\%$. $n = 2$ $N = 10$ # Parejas $= N-1 = 10-1 = 9$

$FE := \dfrac{N-1}{n^2} = \dfrac{9}{4} = 2.25$

Pareja	X N. Rectangular	Y N. Rectangular
1	0.03315	0.01189
2	0.01189	0.01422
3	0.01422	0.33096
4	0.33096	0.43031
5	0.43031	0.90593
6	0.90593	0.05452
7	0.05452	0.86316
8	0.86316	0.71407
9	0.71407	0.50452

$x_0^2 = \dfrac{4}{9}\left[(2-2.25)^2 + (2-2.25)^2 + (4-2.25)^2 + (1-2.25)^2\right] = \dfrac{4}{9}(4.75)$

$x_0^2 = \dfrac{19}{9} = 2.11111$ $x^2_{a, n^2-1} = x^2_{0.05, 4-1} = x^2_{0.05, 3} = 7.81$

$\boxed{x_0^2 = 2.111 < x^2_{0.05, 3} = 7.81}$ Los números rectangulares
                                              son aceptadas.

Prueba de series

b)

0.10461	0.73704	0.68777	0.30231	0.97599
0.95554	0.52861	0.66591	0.21704	0.63379

$a = 5\%$ $n = 2$ $N = 10$ # Parejas $= N-1 = 10-1 = 9$

$FE_i = \dfrac{N-1}{n^2} = \dfrac{9}{4} = 2.25$

Pareja	X N. Rectangular	y N. Rectangular
1	0.10461	0.95554
2	0.95554	0.73704
3	0.73704	0.52861
4	0.52861	0.68777
5	0.68777	0.66591
6	0.66591	0.30231
7	0.30231	0.21704
8	0.21704	0.97599
9	0.97599	0.63379

y		
1	1,8 $\quad = 2$	2,3,4,5,9 $\quad = 5$
½	7	6
0	$= 1$	$= 1$
	0	½	1 $\quad X$

$X_0^2 = \dfrac{4}{9}\left[(2-2.25)^2 + (5-2.25)^2 + (1-2.25)^2 + (1-2.25)^2\right] = \dfrac{4}{9}(10.75)$

$X_0^2 = 43/9 = 4.777777$ $X^2_{a,n^2-1} = X^2_{0.05,3} = 7.81$

$\boxed{X_0^2 = 4.777777 < X^2_{0.05,3} = 7.81}$ Los números rectangulares son aceptados.

Prueba de series

c)

0.43315	0.31422	0.43031	0.15452	0.71427
0.71189	0.33095	0.912593	0.76316	0.50552

$q = 5\%$ $n = 2$ $N = 10$ # Parejas $= N - 1 = 10 - 1 = 9$

$$FE_i = \frac{N-1}{n^2} = \frac{9}{4} = 2.25$$

Pareja	x N. Rectangular	y N. Rectangular
1	0.43315	0.71189
2	0.71189	0.31422
3	0.31422	0.33095
4	0.33095	0.43031
5	0.43031	0.912593
6	0.912593	0.15452
7	0.15452	0.76316
8	0.76316	0.71427
9	0.71427	0.50552

y

1	1,5,7	8,9
	= 3	= 2
1/2	3,4	2,6
	= 2	= 2
0		

0   1/2   1 x

$$x^2_0 = \frac{4}{9}\left[(3-2.25)^2 + (2-2.25)^2 + (2-2.25)^2 + (2-2.25)^2 \right] = \frac{4}{9}(0.75)$$

$$x^2_0 = \frac{3}{9} = 0.333333 \qquad x^2_{a,n-1} = x^2_{0.05,3} = 7.81$$

$$\boxed{x^2_0 = 0.333333 < x^2_{0.05,3} = 7.81}$$

Los números rectangulares
son aceptados.

Prueba de distancias

a)   0.03315   0.01422   0.43031   0.05452   0.71407

     0.01189   0.33096   0.90593   0.86316   0.50452

     $a = 5\%$. $N = 10$

Distancia   0   0.03315   0.01422

                0.01189   0.33096

Distancia   1   0.43031   0.05452

Distancia   2   0.90593   0.50452

                0.86316

Distancia   3   0.71407

i	FO_i	FE_i	
0	4	$(0.1)(0.9)^0 \times 10 = 1$	
1	2	$(0.1)(0.9)^1 \times 10 = 0.9$	FE_i agrupada $< 5 = 1 + 0.9 + 0.81$
2	3	$(0.1)(0.9)^2 \times 10 = 0.81$	(1er. grupo) $\qquad = 2.71$
3	1	$(0.9)^3 \times 10 = 7.29$	FE_i agrupada $> 5 = 7.29$ (2do. grupo)

FO_i agrupada $i < n = 9$

FO_i agrupada $i > n = 1$

$$x^2_0 = \frac{(9-2.71)^2}{2.71} + \frac{(1-7.29)^2}{7.29} = 20.0264 \qquad x^2_{a,n-1} = x^2_{0.05,1} = 3.84$$

$$\boxed{x^2_0 = 20.0264 > x^2_{0.05,1} = 3.84}$$ Los números rectangulares

                                               son rechazados.

Prueba de distancias

b)

| 0.10461 | 0.73704 | 0.68777 | 0.30231 | 0.97599 |
| 0.95554 | 0.52861 | 0.66591 | 0.21704 | 0.63379 |

Debido a que los números 0.95554, 0.52861, 0.68777 y 0.97599 no se puede realizar la prueba, ya que caen en varias distancias o en ninguna, por lo tanto, los números rectangulares son rechazados.

Prueba de distancias

c)   0.43315   0.31422   0.43031   0.15452   0.71427

0.71189   0.33095   0.912593   0.76316   0.50552

Debido a que el número 0.50552 cae en dos distancias no se
puede realizar la prueba, por lo tanto, los números rectangulares
son rechazados

Prueba Poker

a) 0.03315   0.01422   0.43031   0.05452   0.71409 $a = 5\%$. $n = 2$

0.01189   0.33096   0.90593   0.86316   0.50452 $N = 10$

Un par

0.03315   0.90593

0.01189   0.05452

0.01422   0.86316

0.33096   0.71409

6.43031   0.50452

Categoría	FO.	FE.
Un par	10	$0.50400 \times 10 = 5.0400$

FE. agrupada <5 = 4.96   (10-5.04)

FO. agrupada <5 = 0

$$x^2_0 = \frac{(0-4.96)^2}{4.96} + \frac{(10-5.04)^2}{5.04} = 4.96 + 4.8812 = 9.8412$$

$$x^2_{a, n-1} = x^2_{0.05, 1} = 3.84$$

$$\boxed{x^2_0 = 9.8412 > x^2_{0.05, 1} = 3.84}$$ Los números rectangulares

son rechazados.

Prueba Poker

b)
| 0.10461 | 0.73704 | 0.68777 | 0.30231 | 0.97599 | a=5% n=2 |
| 0.95554 | 0.52861 | 0.66591 | 0.21704 | 0.63379 | N=10 |

Diferentes	Un par	Tercia
0.52861	0.10461	0.95554
0.21704	0.73704	0.68777
	0.30231	0.97599
	0.66591	
	0.63379	

Categoría	FO;	FE;
Diferentes	2	0.30240 x 10 = 3.0240
Un par	5	0.50400 x 10 = 5.0400
Tercia	3	0.07200 x 10 = 0.7200

FE; agrupada <5 = 3.0240 + 0.7200 = 3.744

FO; agrupada <5 = 3 + 2 = 5

$$x_0^2 = \frac{(5 - 3.744)^2}{3.744} + \frac{(5 - 5.04)^2}{5.04} = 0.421350 + 0.00031746 = 0.42166$$

$$x_{a,n-1}^2 = x_{0.05,1}^2 = 3.84$$

$$\boxed{x_0^2 = 0.42166 < x_{0.05,1}^2 = 3.84}$$ Los números rectangulares son aceptados.

Prueba Poker

c)

0.43315	0.31422	0.43031	0.15452	0.71427
0.71189	0.33095	0.912593	0.76316	0.50552

Un par   Tercia

0.43315	0.912593		0.50552
0.71189	0.15452
0.31422	0.76316
0.33095	0.71427
0.43031

Categoría	FO_i	FE_i
Un par	9	$0.50400 \times 10 = 5.04$
Tercia	1	$0.07200 \times 10 = 0.7200$

FE_i agrupada $<5 = 0.72$

FO_i agrupada $<5 = 1$

$$x_o^2 = \frac{(1-0.72)^2}{0.72} + \frac{(9-5.04)^2}{5.04} = 0.108888 + 3.1114285 = 3.2203$$

$$x^2_{a,n-1} = x^2_{0.05,1} = 3.84$$

$$\boxed{x_o^2 = 3.2203 < x^2_{0.05,1} = 3.84}$$ Los números rectangulares son aceptados.