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**TECNOLÓGICO NACIONAL DE MEXICO**

**INSTITUTO TECNOLÓGICO DE CIUDAD MADERO**

**Carrera: Sistemas Computacionales**

**Tema: Prueba de Chi Cuadrada**

**Equipo: Rojo Carmesí**

**Integrantes:**

Reyes Villar Luis Ricardo

Rocha Suarez María Fernanda

Hernández del Ángel Ángel Ivan

Garcia Valles Roberto Carlos

**Profesora:** Elizabeth Cortez Razo

**Materia:** Simulación

**Hora:** 10:00 – 11:00 hrs

**Grupo:** 6505A

**Fecha de entrega:** 18 de Mayo del 2023

**Periodo Semestral:** Enero 2023 – Junio 2023

Para la prueba de Chi Cuadrada, prueba de Ajuste de Bondad o prueba de Uniformidad a las variables aleatorias, es necesario establecer ciertos aspectos, ya que al final, la prueba de uniformidad será representada en forma de tabla, se realizarán ciertos cálculos, se obtendrá el valor de la Chi cuadrada teórica y el valor del estadístico; Si el valor del estadístico es menor al valor de la Chi cuadrada teórica, entonces se concluye que el conjunto de variables aleatorias siguen una distribución uniforme y están listas para ser usadas, sino, entonces se rechaza el conjunto de variables aleatorias, ya que se concluye que no siguen una distribución uniforme.

Esto se realiza estableciendo el número de intervalos (m) que es necesario para nuestro problema en específico y el valor del nivel de significancia, en este caso, 0.05. Posteriormente, se realiza el calculo de chi cuadrada teórica:

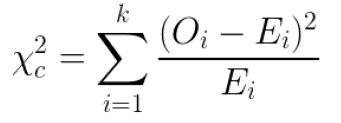
Como siguiente paso, se obtienen los valores máximos (Max) y mínimos (Min) de todo el conjunto de variables aleatorias, se obtiene el rango, siendo la diferencia de el valor máximo menos el valor mínimo.

Posteriormente, se obtiene la amplitud, la amplitud es igual a el rango sobre el numero de categorías o número de intervalos.

Posteriormente, se obtiene el valor de la Frecuencia Esperada (FE) que es la probabilidad de cada intervalo multiplicado por el total de valores del conjunto.

Posteriormente, se comienza a establecer los valores de los límites inferiores y superiores para cada intervalo respectivamente, para la primera categoría el valor del limite inferior es igual al valor mínimo del conjunto. Posteriormente, para obtener el limite superior se suma el valor del limite inferior más el valor de la amplitud, para la segunda categoría y las siguientes el valor del limite inferior será igual al valor del limite superior de la anterior categoría o intervalo, y el valor del limite superior de ese intervalo es igual al limite inferior mas la amplitud, así sucesivamente hasta el último intervalo.

Por consiguiente, se obtiene el valor de la frecuencia observada de cada categoría, el valor de la frecuencia observada será el numero de variables aleatorias del conjunto dado que caen dentro de los limites de cada categoría, una vez obtenidos todos esos valores, se puede aplicar la formula para obtener el estadístico, la formula es la sumatoria de las frecuencias observadas menos la frecuencia esperada, elevado al cuadrado sobre la frecuencia esperada, es decir:



Por último, se realiza la comparación anteriormente mencionada y se concluye con la prueba.

**Demostración.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Ri | | | Xi | | |
|  | | Numero Aleatorio | | | Demanda (Variable Aleatoria) | | |
| **1** | | **0.09286** | | | **9.745848576** | | |
| **2** | | **0.86229** | | | **198.2605254** | | |
| **3** | | **0.3544** | | | **43.7575162** | | |
| **4** | | **0.55993** | | | **82.08214738** | | |
| **5** | | **0.35216** | | | **43.41115267** | | |
| **6** | | **0.40166** | | | **51.35961247** | | |
| **7** | | **0.13307** | | | **14.27970436** | | |
| **8** | | **0.77076** | | | **147.2985789** | | |
| **9** | | **0.40709** | | | **52.27126622** | | |
| **10** | | **0.57222** | | | **84.91462342** | | |
| **11** | | **0.74357** | | | **136.0899556** | | |
| **12** | | **0.28963** | | | **34.19693179** | | |
| **13** | | **0.38855** | | | **49.19220933** | | |
| **14** | | **0.09711** | | | **10.21545492** | | |
| **15** | | **0.94303** | | | **286.5230465** | | |
| **16** | | **0.93055** | | | **266.714821** | | |
| **17** | | **0.59233** | | | **89.72972554** | | |
| **18** | | **0.08548** | | | **8.935594152** | | |
| **19** | | **0.73068** | | | **131.1855015** | | |
| **20** | | **0.38932** | | | **49.31821886** | | |
| **21** | | **0.157** | | | **17.0788321** | | |
| **22** | | **0.4649** | | | **62.53016337** | | |
| **23** | | **0.6132** | | | **94.98475154** | | |
| **24** | | **0.60142** | | | **91.98470481** | | |
| **25** | | **0.1706** | | | **18.70527312** | | |
| **26** | | **0.91043** | | | **241.2734836** | | |
| **27** | | **0.88827** | | | **219.1670032** | | |
| **28** | | **0.90235** | | | **232.6365622** | | |
| **29** | | **0.42355** | | | **55.08666733** | | |
| **30** | | **0.93946** | | | **280.4450975** | | |
| **31** | | **0.2585** | | | **29.90801174** | | |
| **32** | | **0.68222** | | | **114.639596** | | |
| **33** | | **0.54241** | | | **78.17816923** | | |
| **34** | | **0.42086** | | | **54.62110344** | | |
| **35** | | **0.71231** | | | **124.5871767** | | |
| **36** | | **0.73855** | | | **134.1512218** | | |
| **37** | | **0.54561** | | | **78.87994189** | | |
| **38** | | **0.76902** | | | **146.5424152** | | |
| **39** | | **0.13917** | | | **14.98582389** | | |
| **40** | | **0.93682** | | | **276.1767484** | | |
| **41** | | **0.76317** | | | **144.0412695** | | |
| **42** | | **0.24284** | | | **27.81806872** | | |
| **43** | | **0.89712** | | | **227.4192018** | | |
| **44** | | **0.48242** | | | **65.85911764** | | |
| **45** | | **0.2729** | | | **31.86912593** | | |
| **46** | | **0.44744** | | | **59.31932542** | | |
| **47** | | **0.02025** | | | **2.04578419** | | |
| **48** | | **0.041** | | | **4.18642041** | | |
| **49** | | **0.1681** | | | **18.40430377** | | |
| **50** | | **0.82576** | | | **174.732162** | | |
| **51** | | **0.18795** | | | **20.81933644** | | |
| **52** | | **0.53252** | | | **76.03987119** | | |
| **53** | | **0.35775** | | | **44.2777643** | | |
| **54** | | **0.7985** | | | **160.1965898** | | |
| **55** | | **0.76022** | | | **142.8033443** | | |
| **56** | | **0.79344** | | | **157.7164352** | | |
| **57** | | **0.9547** | | | **309.4448246** | | |
| **58** | | **0.1452** | | | **15.68877555** | | |
| **59** | | **0.1083** | | | **11.46255258** | | |
| **60** | | **0.17288** | | | **18.98054917** | | |
| Maximo | | | | 309.4448246 | |
| Minimo | | | | 2.04578419 | |
| Rango | | | | 307.3990405 | |
| Clases | | | | 58 | |
| Amplitud | | | | 5.299983456 | |
| Frecuencia Esperada | | | | 1.034482759 | |
| **Categoría** | **LI** | | **LS** | | | | **FO** | |  |
| **1** | **2.04578419** | | **7.345767646** | | | | **2** | | **0.901149425** |
| **2** | **7.345767646** | | **12.6457511** | | | | **4** | | **8.501149425** |
| **3** | **12.6457511** | | **17.94573456** | | | | **4** | | **8.501149425** |
| **4** | **17.94573456** | | **23.24571802** | | | | **4** | | **8.501149425** |
| **5** | **23.24571802** | | **28.54570147** | | | | **1** | | **0.001149425** |
| **6** | **28.54570147** | | **33.84568493** | | | | **2** | | **0.901149425** |
| **7** | **33.84568493** | | **39.14566838** | | | | **1** | | **0.001149425** |
| **8** | **39.14566838** | | **44.44565184** | | | | **3** | | **3.734482759** |
| **9** | **44.44565184** | | **49.7456353** | | | | **2** | | **0.901149425** |
| **10** | **49.7456353** | | **55.04561875** | | | | **3** | | **3.734482759** |
| **11** | **55.04561875** | | **60.34560221** | | | | **2** | | **0.901149425** |
| **12** | **60.34560221** | | **65.64558566** | | | | **1** | | **0.001149425** |
| **13** | **65.64558566** | | **70.94556912** | | | | **1** | | **0.001149425** |
| **14** | **70.94556912** | | **76.24555258** | | | | **1** | | **0.001149425** |
| **15** | **76.24555258** | | **81.54553603** | | | | **2** | | **0.901149425** |
| **16** | **81.54553603** | | **86.84551949** | | | | **2** | | **0.901149425** |
| **17** | **86.84551949** | | **92.14550295** | | | | **2** | | **0.901149425** |
| **18** | **92.14550295** | | **97.4454864** | | | | **1** | | **0.001149425** |
| **19** | **97.4454864** | | **102.7454699** | | | | **0** | | **1.034482759** |
| **20** | **102.7454699** | | **108.0454533** | | | | **0** | | **1.034482759** |
| **21** | **108.0454533** | | **113.3454368** | | | | **0** | | **1.034482759** |
| **22** | **113.3454368** | | **118.6454202** | | | | **1** | | **0.001149425** |
| **23** | **118.6454202** | | **123.9454037** | | | | **0** | | **1.034482759** |
| **24** | **123.9454037** | | **129.2453871** | | | | **1** | | **0.001149425** |
| **25** | **129.2453871** | | **134.5453706** | | | | **2** | | **0.901149425** |
| **26** | **134.5453706** | | **139.8453541** | | | | **1** | | **0.001149425** |
| **27** | **139.8453541** | | **145.1453375** | | | | **2** | | **0.901149425** |
| **28** | **145.1453375** | | **150.445321** | | | | **2** | | **0.901149425** |
| **29** | **150.445321** | | **155.7453044** | | | | **0** | | **1.034482759** |
| **30** | **155.7453044** | | **161.0452879** | | | | **2** | | **0.901149425** |
| **31** | **161.0452879** | | **166.3452713** | | | | **0** | | **1.034482759** |
| **32** | **166.3452713** | | **171.6452548** | | | | **0** | | **1.034482759** |
| **33** | **171.6452548** | | **176.9452382** | | | | **1** | | **0.001149425** |
| **34** | **176.9452382** | | **182.2452217** | | | | **0** | | **1.034482759** |
| **35** | **182.2452217** | | **187.5452052** | | | | **0** | | **1.034482759** |
| **36** | **187.5452052** | | **192.8451886** | | | | **0** | | **1.034482759** |
| **37** | **192.8451886** | | **198.1451721** | | | | **0** | | **1.034482759** |
| **38** | **198.1451721** | | **203.4451555** | | | | **1** | | **0.001149425** |
| **39** | **203.4451555** | | **208.745139** | | | | **0** | | **1.034482759** |
| **40** | **208.745139** | | **214.0451224** | | | | **0** | | **1.034482759** |
| **41** | **214.0451224** | | **219.3451059** | | | | **1** | | **0.001149425** |
| **42** | **219.3451059** | | **224.6450894** | | | | **0** | | **1.034482759** |
| **43** | **224.6450894** | | **229.9450728** | | | | **1** | | **0.001149425** |
| **44** | **229.9450728** | | **235.2450563** | | | | **1** | | **0.001149425** |
| **45** | **235.2450563** | | **240.5450397** | | | | **0** | | **1.034482759** |
| **46** | **240.5450397** | | **245.8450232** | | | | **1** | | **0.001149425** |
| **47** | **245.8450232** | | **251.1450066** | | | | **0** | | **1.034482759** |
| **48** | **251.1450066** | | **256.4449901** | | | | **0** | | **1.034482759** |
| **49** | **256.4449901** | | **261.7449735** | | | | **0** | | **1.034482759** |
| **50** | **261.7449735** | | **267.044957** | | | | **1** | | **0.001149425** |
| **51** | **267.044957** | | **272.3449405** | | | | **0** | | **1.034482759** |
| **52** | **272.3449405** | | **277.6449239** | | | | **1** | | **0.001149425** |
| **53** | **277.6449239** | | **282.9449074** | | | | **1** | | **0.001149425** |
| **54** | **282.9449074** | | **288.2448908** | | | | **1** | | **0.001149425** |
| **55** | **288.2448908** | | **293.5448743** | | | | **0** | | **1.034482759** |
| **56** | **293.5448743** | | **298.8448577** | | | | **0** | | **1.034482759** |
| **57** | **298.8448577** | | **304.1448412** | | | | **0** | | **1.034482759** |
| **58** | **304.1448412** | | **309.4448346** | | | | **1** | | **0.001149425** |
|  |  | |  | | | | **60** | | **65.66666667** |
|  |  | |  | | | | **Chi cuadrada teórica:** | | **75.62374847** |

**Se concluye que el conjunto de variables aleatorias sigue una distribución uniforme.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Ri | | | Xi | | |
|  | | Numero Aleatorio | | | Demanda (Variable Aleatoria) | | |
| **1** | | **0.9654** | | | **336.3901597** | | |
| **2** | | **0.19971** | | | **22.2781117** | | |
| **3** | | **0.9884** | | | **445.6750181** | | |
| **4** | | **0.69345** | | | **118.2374405** | | |
| **5** | | **0.08729** | | | **9.133708302** | | |
| **6** | | **0.76195** | | | **143.5274543** | | |
| **7** | | **0.05678** | | | **5.845572557** | | |
| **8** | | **0.32239** | | | **38.91833778** | | |
| **9** | | **0.39353** | | | **50.0100016** | | |
| **10** | | **0.48658** | | | **66.66610553** | | |
| **11** | | **0.676** | | | **112.7011763** | | |
| **12** | | **0.6976** | | | **119.6004635** | | |
| **13** | | **0.66457** | | | **109.2341988** | | |
| **14** | | **0.16532** | | | **18.07068611** | | |
| **15** | | **0.73307** | | | **132.0768827** | | |
| **16** | | **0.73916** | | | **134.3848086** | | |
| **17** | | **0.63575** | | | **100.9914834** | | |
| **18** | | **0.4178** | | | **54.09412477** | | |
| **19** | | **0.45568** | | | **60.82179698** | | |
| **20** | | **0.76442** | | | **144.570472** | | |
| **21** | | **0.43379** | | | **56.87902449** | | |
| **22** | | **0.81737** | | | **170.0293031** | | |
| **23** | | **0.80937** | | | **165.7420902** | | |
| **24** | | **0.50797** | | | **70.92155887** | | |
| **25** | | **0.80335** | | | **162.632978** | | |
| **26** | | **0.53712** | | | **77.02874378** | | |
| **27** | | **0.84978** | | | **189.5654393** | | |
| **28** | | **0.2126** | | | **23.90189005** | | |
| **29** | | **0.51987** | | | **73.36983784** | | |
| **30** | | **0.02648** | | | **2.683690995** | | |
| **31** | | **0.07011** | | | **7.26889794** | | |
| **32** | | **0.49154** | | | **67.63687293** | | |
| **33** | | **0.16115** | | | **17.57233728** | | |
| **34** | | **0.59693** | | | **90.86450348** | | |
| **35** | | **0.63254** | | | **100.114081** | | |
| **36** | | **0.01068** | | | **1.073744054** | | |
| **37** | | **0.0114** | | | **1.146547811** | | |
| **38** | | **0.01299** | | | **1.307510789** | | |
| **39** | | **0.01687** | | | **1.701391936** | | |
| **40** | | **0.02845** | | | **2.886254469** | | |
| **41** | | **0.08094** | | | **8.44038704** | | |
| **42** | | **0.65512** | | | **106.4558749** | | |
| **43** | | **0.91822** | | | **250.3722564** | | |
| **44** | | **0.31279** | | | **37.51153566** | | |
| **45** | | **0.78375** | | | **153.1320133** | | |
| **46** | | **0.4264** | | | **55.58229897** | | |
| **47** | | **0.18169** | | | **20.05140411** | | |
| **48** | | **0.30112** | | | **35.82762253** | | |
| **49** | | **0.06732** | | | **6.96931166** | | |
| **50** | | **0.45319** | | | **60.36538861** | | |
| **51** | | **0.53811** | | | **77.24285115** | | |
| **52** | | **0.95623** | | | **312.8806628** | | |
| **53** | | **0.43758** | | | **57.55063772** | | |
| **54** | | **0.14762** | | | **15.97228422** | | |
| **55** | | **0.17916** | | | **19.74270728** | | |
| **56** | | **0.20983** | | | **23.55071668** | | |
| **57** | | **0.40286** | | | **51.56036872** | | |
| **58** | | **0.22961** | | | **26.08583989** | | |
| **59** | | **0.27207** | | | **31.75503893** | | |
| **60** | | **0.4022** | | | **51.44990291** | | |
| Maximo | | | 445.6750181 | | |
| Minimo | | | 1.073744054 | | |
| Rango | | | 444.601274 | | |
| Clases | | | 58 | | |
| Amplitud | | | 7.665539207 | | |
| Frecuencia Esperada | | | 1.034482759 | | |
| **Categoría** | **LI** | | | **LS** | | | **FO** | |  |
| **1** | **1.073744054** | | | **8.739283262** | | | **10** | | **77.70114943** |
| **2** | **8.739283262** | | | **16.40482247** | | | **2** | | **0.901149425** |
| **3** | **16.40482247** | | | **24.07036168** | | | **7** | | **34.40114943** |
| **4** | **24.07036168** | | | **31.73590088** | | | **1** | | **0.001149425** |
| **5** | **31.73590088** | | | **39.40144009** | | | **4** | | **8.501149425** |
| **6** | **39.40144009** | | | **47.0669793** | | | **0** | | **1.034482759** |
| **7** | **47.0669793** | | | **54.73251851** | | | **4** | | **8.501149425** |
| **8** | **54.73251851** | | | **62.39805771** | | | **5** | | **15.20114943** |
| **9** | **62.39805771** | | | **70.06359692** | | | **2** | | **0.901149425** |
| **10** | **70.06359692** | | | **77.72913613** | | | **4** | | **8.501149425** |
| **11** | **77.72913613** | | | **85.39467534** | | | **0** | | **1.034482759** |
| **12** | **85.39467534** | | | **93.06021454** | | | **1** | | **0.001149425** |
| **13** | **93.06021454** | | | **100.7257538** | | | **1** | | **0.001149425** |
| **14** | **100.7257538** | | | **108.391293** | | | **2** | | **0.901149425** |
| **15** | **108.391293** | | | **116.0568322** | | | **2** | | **0.901149425** |
| **16** | **116.0568322** | | | **123.7223714** | | | **2** | | **0.901149425** |
| **17** | **123.7223714** | | | **131.3879106** | | | **0** | | **1.034482759** |
| **18** | **131.3879106** | | | **139.0534498** | | | **2** | | **0.901149425** |
| **19** | **139.0534498** | | | **146.718989** | | | **2** | | **0.901149425** |
| **20** | **146.718989** | | | **154.3845282** | | | **1** | | **0.001149425** |
| **21** | **154.3845282** | | | **162.0500674** | | | **0** | | **1.034482759** |
| **22** | **162.0500674** | | | **169.7156066** | | | **2** | | **0.901149425** |
| **23** | **169.7156066** | | | **177.3811458** | | | **1** | | **0.001149425** |
| **24** | **177.3811458** | | | **185.046685** | | | **0** | | **1.034482759** |
| **25** | **185.046685** | | | **192.7122242** | | | **1** | | **0.001149425** |
| **26** | **192.7122242** | | | **200.3777634** | | | **0** | | **1.034482759** |
| **27** | **200.3777634** | | | **208.0433027** | | | **0** | | **1.034482759** |
| **28** | **208.0433027** | | | **215.7088419** | | | **0** | | **1.034482759** |
| **29** | **215.7088419** | | | **223.3743811** | | | **0** | | **1.034482759** |
| **30** | **223.3743811** | | | **231.0399203** | | | **0** | | **1.034482759** |
| **31** | **231.0399203** | | | **238.7054595** | | | **0** | | **1.034482759** |
| **32** | **238.7054595** | | | **246.3709987** | | | **0** | | **1.034482759** |
| **33** | **246.3709987** | | | **254.0365379** | | | **1** | | **0.001149425** |
| **34** | **254.0365379** | | | **261.7020771** | | | **0** | | **1.034482759** |
| **35** | **261.7020771** | | | **269.3676163** | | | **0** | | **1.034482759** |
| **36** | **269.3676163** | | | **277.0331555** | | | **0** | | **1.034482759** |
| **37** | **277.0331555** | | | **284.6986947** | | | **0** | | **1.034482759** |
| **38** | **284.6986947** | | | **292.3642339** | | | **0** | | **1.034482759** |
| **39** | **292.3642339** | | | **300.0297731** | | | **0** | | **1.034482759** |
| **40** | **300.0297731** | | | **307.6953124** | | | **0** | | **1.034482759** |
| **41** | **307.6953124** | | | **315.3608516** | | | **1** | | **0.001149425** |
| **42** | **315.3608516** | | | **323.0263908** | | | **0** | | **1.034482759** |
| **43** | **323.0263908** | | | **330.69193** | | | **0** | | **1.034482759** |
| **44** | **330.69193** | | | **338.3574692** | | | **1** | | **0.001149425** |
| **45** | **338.3574692** | | | **346.0230084** | | | **0** | | **1.034482759** |
| **46** | **346.0230084** | | | **353.6885476** | | | **0** | | **1.034482759** |
| **47** | **353.6885476** | | | **361.3540868** | | | **0** | | **1.034482759** |
| **48** | **361.3540868** | | | **369.019626** | | | **0** | | **1.034482759** |
| **49** | **369.019626** | | | **376.6851652** | | | **0** | | **1.034482759** |
| **50** | **376.6851652** | | | **384.3507044** | | | **0** | | **1.034482759** |
| **51** | **384.3507044** | | | **392.0162436** | | | **0** | | **1.034482759** |
| **52** | **392.0162436** | | | **399.6817828** | | | **0** | | **1.034482759** |
| **53** | **399.6817828** | | | **407.347322** | | | **0** | | **1.034482759** |
| **54** | **407.347322** | | | **415.0128613** | | | **0** | | **1.034482759** |
| **55** | **415.0128613** | | | **422.6784005** | | | **0** | | **1.034482759** |
| **56** | **422.6784005** | | | **430.3439397** | | | **0** | | **1.034482759** |
| **57** | **430.3439397** | | | **438.0094789** | | | **0** | | **1.034482759** |
| **58** | **438.0094789** | | | **445.6750181** | | | **1** | | **0.001149425** |
|  |  | | |  | | | **60** | | **195.2** |
|  |  | | |  | | | **Chi cuadrada teórica:** | | **75.62374847** |

**Se concluye que el conjunto de variables aleatorias es rechazado, ya que no sigue una distribución uniforme.**