Mutually Exclusive : $A \cap B = \phi$; $P(A \cup B) = P(A) + P(B)$

Collectively Exhaustive events : $A \cup B$ = sample space.

Independent Events = $P(A \cap B) = P(A) \cdot P(B)$

$$P\left(\frac{A}{B}\right) = \frac{P(A \cap B)}{P(B)}$$

Random V (X)

Discrete

PMF : $1 \geq P(x) \geq 0$

$\sum P(x) = 1$

→ Binomial
→ Poisson

Continuous.

PDF : $f(x) \geq 0$

$\int_{-\infty}^{\infty} f(x) = 1$

→ Uniform
→ Normal
→ Exponential

PMF / PDF are same, depends on context.

eg:

x	0	1	2
P(x)	a	b	c

x	Interval	I_2	I_3
P(x)	a	b	c

Cumulative DF

x	0	1	2
f(x)	a	a+b	a+b+c

Prefix sums.

Cumulative density Func is same but can't add directly, so we integrate in that range.

Mean = $\bar{x}$

$E(x) = \sum x \, P(x)$

$\bar{x} = \int x \, P(x) = E(x)$

Variance = $E(x^2) - (E(x))^2$

sum of sq. − sq. of sum.

Variance calculate

$E(x^2) = \int x^2 P(x)$

$$\boxed{\text{Gamma function} \quad \int_0^\infty x^{n-1} e^{-ax} dx = \frac{\Gamma n}{a^n}}$$

gamma

Mean of general function :

$E(\phi(x)) = \sum \phi(x) \, p(x)$

or $\int \phi(x) f(x) \, dx$

Binomial Distribution : $n \to$ finite.

$P(x) = {}^nC_x \, p^x q^{n-x}$ $[p+q=1]$ ~~p+q~~

PMF = $[p+q]^n = 1^n = 1$

$\boxed{\text{mean} = np \quad \text{variance} = npq}$

binomial

MGF (Moment generating function) = $E(e^{xt})$

$E(e^{xt}) = (pe^t + q)^n$ ← solve

Characteristic Fun : $E(e^{ixt})$ $t \to it$

characterstic function

→ $(pe^{it} + q)^n$

PGF (Probability Generating Function)

→ $E(z^x) = (zp + q)^n$

2nd sem syllabus

pgf probability generating

Poisson Distribution : $n \to \infty$ $p \to 0$ but np is finite.

poission

PMF = $P(x) = \frac{\lambda^x e^{-\lambda}}{x!}$

where λ = mean = np

$\boxed{\text{Mean} = \text{Variance}}$

$\sigma^2 = E(x^2) - (E(x))^2$

$= \lambda^2 + \lambda - \lambda^2 = \lambda$

MGF = $e^{\lambda(e^t - 1)}$ PGF = $e^{\lambda(z-1)}$

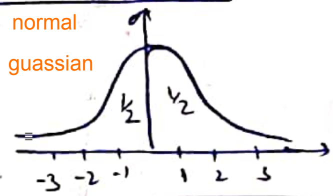
Normal Distribution / Gaussian Distribution

normal

guassian

Mean = Median = Mode

$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$



$\sigma^2 \to$ variance

$\mu \to$ mean.

$\boxed{\frac{x-\mu}{\sigma} = Z}$

Area : $(-1 < Z < 1)$: 0.68

$(-2 < Z < 2)$: 0.95

$(-3 < Z < 3)$: 0.99

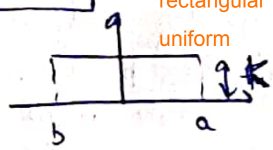
$(-\infty < Z < \infty)$: 1

Rectangular / Uniform distribution

rectangular

uniform

$f(x) = \begin{cases} K & b < x < a \\ 0 & \text{else} \end{cases}$



We know $\int_{-\infty}^{\infty} f(x) = 1$ = Area

→ so $\boxed{K = \frac{1}{a-b}}$ mgf (e^tb - e^ta) / (b-a)t

$\boxed{\text{mean} = \frac{a+b}{2} = E(x) \quad \cancel{E(x^2)} \text{ Variance} = \frac{(b-a)^2}{12}}$

Moments | Representation → $\mu \to \mu^0$, $\mu' \to \mu^1$, $\mu'' \to \mu^2$

moments

about Origin	Mean	Any value
$\mu_r^1 = E(x-0)^r$	$\mu_r^0 = E(x-\bar{x})^r$	$\mu_r^2 = E(x-A)^r$
$\mu_0^1 = 1$	$\mu_0^0 = 1$	
$\boxed{\mu_1^1 = \bar{x} = \text{Mean}}$	$\boxed{\mu_1^0 = 0}$	
$\mu_2^1 = E(x^2)$	$\boxed{\mu_2^0 = \mu_2^1 - (\mu_1^1)^2 \text{ Variance}}$	
$\mu_3^1 = E(x^3)$	$\mu_3^0 = \mu_3^1 - 3\mu_2^1\mu_1^1 + 2(\mu_1^1)^3$	
	$\mu_4^0 = \mu_4^1 - 4\mu_3^1\mu_1^1 + 6\mu_2^1\mu_1^{1\,2} - 3\mu_1^{1\,4}$	

BORING

exponent distribution function
f(x) = (lambda)e^(-lambda*x)
where lambda>0 and x={0, inf}
mean = 1/lam
variance = /(lam^2)
mgf : lam / (t -lam)

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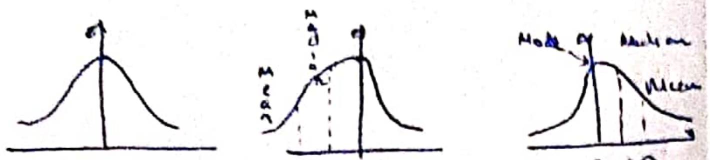
1st derivative of moment genrating func gives mean and second gives variance.

Skewness : lack of symmetry.

skewness

$$\boxed{\beta_1 = \frac{(\mu_3')^2}{(\mu_2')^3}}$$

$\mu_r' \to$ about mean



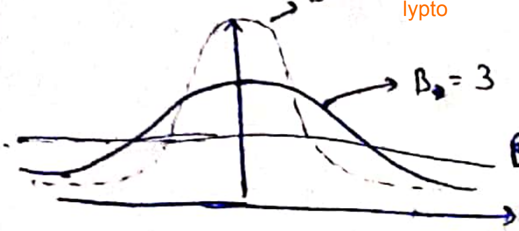
$\beta_1 = 0$ $\beta_1 < 0$ $\beta_1 > 0$

Mean = Median = Mode   −ve skewed.   +ve skewed

Kurtosis | Flatness of curve | Bell shape

kurtosis
karl

$$\beta_2 = \frac{\mu_4'}{(\mu_2')^2}$$



$\beta > 3$ (Lyptokurtic) lypto

$\beta_2 = 3$ (Mesokurtic) meso

$\beta < 3$ (Platykurtic) platy

LMP

$$\text{Mean} = \frac{\sum x_i f_i}{\sum f_i}$$ ← used while calculating moments etc.

Preferably find about a point and on back page replace $\mu^1 \to \mu^2$ to calculate about mean (lengthy)

Bivariate RV | 2 dimension | $P(X = x_i, Y = y_j) = P_{ij}$

Joint PMF = joint bivariate
(i) $P_{ij} \geq 0$
(ii) $\sum\sum P_{ij} = 1$

~~pair~~ triplet = (x_i, y_j, P)

Marginal PMF:

for $P(X = x_i) = \sum_j P_{ij} = P_{i1} + P_{i2} + P_{i3} \cdot\cdot P_{im}$

collection of pair $(x_i, P_i) \to$ MGF of x

for $P(Y = y_j) = \sum_i P_{ij} = P_{1j} + P_{2j} + P_{3j} \cdot\cdot P_{nj}$

If X and Y are independent:

$$P_{XY}(x,y) = P_X(x)\, P_Y(y)$$

i.e solve in 1d and ∗

marginal

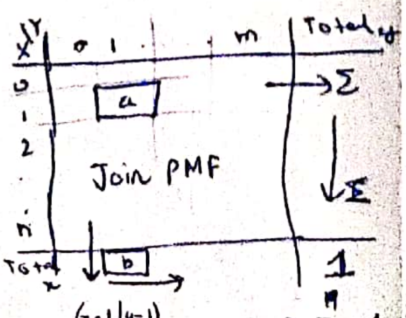
$x = 0, 1 \cdot\cdot n$
$y = 0, 1 \cdot\cdot m$

Marginal X

X	Total y
0	
1	
2	
n	

Marg Y

Y	Total x
0	
1	
2	
m	



$\sum\sum = 1$

conditional PMF $\left(\cancel{X=1}\right)^{(x=1|y=1)} = \frac{a}{b}$

Distributions | with replacement → independent trial
without → not independent

binomial

(i) **Binomial**: → $P(x) = {}^nC_x\, p^x (1-p)^x$ independent trials

$$\boxed{\text{mean} = np \qquad \sigma^2 = npq}$$

(ii) **Hypergeometric**: dependent trials. hypergeometric

$n \to$ objects $a \to$ success $(N-a)$ failure

$$P(X = x) = \frac{\binom{a}{x}\binom{N-a}{n-x}}{\binom{N}{n}}$$

$$\boxed{\text{Mean} = n\frac{a}{N} \qquad \sigma^2 = ?}$$

↳ solve normally without natural formula.

Sometime Ans of Binomic ~ Hypergeom ($\sim 5\%$ error)

(iii) **Geometric**: First success on x^{th} trial. geo geometric

i.e. (i) $(x-1) \to$ failure i.e $(1-p)^{x-1}$
(ii) x^{th} must be success p

$$\text{PMF} = P(X = x) = (1-p)^{x-1} p$$

$$\boxed{\text{mean} = \frac{1}{p} \qquad \sigma^2 = \frac{1-p}{p^2}}$$

$P(X \leq x) = 1 - (1-p)^x$

Negative Binomial: negative

(i) First $(x-1)$ trials → $(r-1)$ success (solve via Binomial)
(ii) x^{th} → success

$$\boxed{\text{mean} = \frac{r}{p} \qquad \sigma^2 = \frac{r(1-p)}{p^2}}$$

Multinomial

$$P(X = x_1, Y = y_1) = {}^nC_x\, p^x q^y = \frac{n!}{x!(n-x)!} p^x q^y = \frac{n!}{x!\,y!} p^x q^y$$

multinomial
multi

General

$$P(X = x_1 \ldots Y = x_n) = \frac{n!}{\lfloor x_1 \lfloor x_2 \cdot\cdot \lfloor x_n} p_1^{x_1} p_2^{x_2} \cdots (p_n)^{x_n}$$

$x_i = 0, 1, 2 \ldots n$

$\sum x_i = 1$

mgf change origin and scale :

y = (x-a)/h   (origin shift of +a and scale of h)

My(t) = e^(-at/h) Mx(t/h)

cumulates distribution func = log(MGF)

→ Chebyshev's thrm is an inequality that can be applied to all data sets. It gives minimum proportion of the measurements that must lie within more than one standard deviations of mean.

chebyshevs chetan

chef

For k standard deviation → $\underbrace{1 - \frac{1}{k^2}}$ $k > 1$

atleast this % data will lie within k std dev

upper value
↓

$$K = \frac{X - \text{mean}}{\sigma^2}$$

~~K has to be integer~~.

inequality

→ Markov's Inequality :

markovs

$$P(x \geq a) \leq \frac{E[x]}{a}$$

if only mean is given and we want to found upper bound use Markov's.

mean + s.d is given → Chebyshev's thrm.

→ Fitting a distribution mean?

(linear) Given 2 parameter ~~and~~ (x axis, y axis) and some points on plane to corresponding x-y pairs. We test and analyse them and try to find the best fit curve ~~or~~ for them. So we can do Hypothesis testing on there

eg: plot weight of bat (θ) vs runs scored using that weighted bat. (Y)

linear variable = $Y = \beta_0 + \beta_1 X$

other model = $f(y) = \theta e^{-\theta y}$ $f(y)$ = PdF.

Fitting of distribution means finding θ for given set of (T).

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Curve fitting of straight line and Parabola (least square

Linear

$$y = a + bx$$

$$\boxed{\Sigma y = na + b\Sigma x}$$

$$xy = ax + bx^2$$

$$\boxed{\Sigma xy = a\Sigma x + b\Sigma x^2}$$

Find a and b here

quadratic.

$$y = a + bx + cx^2$$

$$\boxed{\begin{aligned} \Sigma y &= an + b\Sigma x + c\Sigma x^2 \\ \Sigma xy &= a\Sigma x + b\Sigma x^2 + c\Sigma x^3 \\ \Sigma x^2 y &= a\Sigma x^2 + b\Sigma x^3 + c\Sigma x^4 \end{aligned}}$$

find a, b, c.

Exponential :

$$y = a e^{bx}$$

$$\log y = \log a + bx \log e \quad \text{(base 10)}$$

$$Y = A + bX$$

$$Y = A + bX \leftarrow \text{linear.}$$

→ **Fitting of Normal distribution** → Method of ordinate / → Method of Area

→ **Method of Ordinates!**

- calculate mean
- calculate ~~standard~~ standard dev
- Table (Given $\{x_i, f_i\}$

$$z = \frac{x - \bar{x}}{\sigma}$$

Table value

↳ we will find expected freq.

Our table given — what we calculate $\bar{x}, \sigma$

x_i	f_i	$z = \frac{x-\bar{x}}{\sigma}$	Table value $\phi =$ → from table of ordinate.	frequen $y = \frac{N}{\sigma}(\phi z)$	Expected freq $= y \times$ class Interval $y \times (x_i - x_{i-1})$

x_i	f_i	$z = \frac{x-\bar{x}}{\sigma}$	$\phi =$ ↑ From table	$y = \frac{\Sigma f_i}{\sigma}(\phi z)$	$y \times (x_i - x_{i-1})$ (C.I)

Method of Area : Area under normal distribution will represent total no of freq. (Table is used, maam vahi pechlega).

area

Steps → Mean
→ Variance
→ Create Table.

find mean and variance.

Use table

Given

Class Interval	$freq_i$	Midpoint I $Z = \frac{x - \bar{x}}{\sigma}$	Area	ΔA	frequency
$x - y$				$\Delta A_i = \lvert Area_i \pm Area_{i+1} \rvert$	$\Delta A \times N$
$y - z$				$\pm$ depends on which side.	
⋯					

convert to x_i i.e. $x_i = x$
$x_{i+1} = y$
$x_{i+2} = z$

* Beta Distribution of 1'st kind

beta distribution kind1

beta1 1

If pdf of $f(x) = \begin{cases} \dfrac{x^{m-1}(1-x)^{n-1}}{\beta(m,n)} & ; 0 \le x \le 1 \quad ; m,n > 0 \\ 0 & ; \text{else} \end{cases}$

then X follows β-distr of I kind

so $\int_{-\infty}^{\infty} f(x) = 1$

$$\Rightarrow \int_0^1 f(x) = 1 = \int_0^1 \frac{x^{m-1}(1-x)^{n-1}}{\beta(m,n)}\,dx$$

$$= \frac{\beta(m,n)}{\beta(m,n)}$$

~~Mean~~ Moment about origin

$$\mu_r' = E[x^r]$$

$$= \frac{\beta(m+r, n)}{\beta(m,n)} = \frac{\Gamma(m+r)\,\Gamma n}{\Gamma(m+n+r)} \cdot \frac{\Gamma(m+n)}{\Gamma m\,\Gamma n}$$

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$$\boxed{\text{Moment about origin} \rightarrow \frac{\Gamma m+r \; \Gamma m+n}{\Gamma m+n+r \; \Gamma m}}$$

Now $\underline{\text{mean}} = \mu_1'$

$\underline{\text{variance}} = \mu_2' - (\mu_1')^2$ = mn / ((m+n)^2 (m+n+1))

mean $\mu_1' = \frac{m}{m+n}$ $\qquad \mu_2' = \frac{m(m+1)}{(m+n)(m+n+1)}$

* Beta Distribution → 2 Type

beta2

$$f(x) = \begin{cases} \frac{1}{B(m,n)} \cdot \frac{x^{m-1}}{(1+x)^{m+n}} & ; x \geq 0, \; m,n > 0 \\ 0 & \end{cases}$$

Moment about origin. $= \mu_r' = E[x^r]$

$$\Rightarrow \int_0^\infty x^r \frac{x^{m-1}}{B(m,n)\,(1+x)^{m+n}} dx$$

$$\boxed{\mu_r' = \frac{\Gamma n-r \; \Gamma m+r}{\Gamma m \; \Gamma n}}$$

mean $= \mu_1'$

variance $= \mu_2' - (\mu_1')^2$ = m(m+n+1) / (n-2)(n-1)(n-1)

mean $\mu_1 = \frac{m}{n-1}$ $\qquad \mu_2 = \frac{m(m+1)}{(n-1)(n-2)}$

* GAMMA DISTRIBUTION

gamma

PdF is $\quad f(x) = \begin{cases} \frac{a^m x^{m-1} e^{-ax}}{\Gamma m} & ; \; x \geq 0 \\ 0 & ; \; \text{else} \end{cases}$

$G(m, a)$.

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Moment about origin.

mean $\mu_1 = \frac{m}{a}$ $\mu_2 = \frac{(m+1)m}{a^2}$

$\mu_3 = \frac{m(m+1)(m+2)}{a^3}$

Cauchy Distribution: cauchy

PDF is $f(x) = \begin{cases} \frac{1}{\pi} \cdot \frac{1}{1+x^2} & -\infty < x < \infty \\ & \text{else.} \end{cases}$

let $y = \frac{x-\mu}{\lambda}$

$g(y) = \begin{cases} \frac{\lambda}{\pi} \frac{1}{\lambda^2 + (y-\mu)^2} & ; -\infty < y < \infty \\ & -\infty < \mu < \infty \\ & \lambda > 0 \\ 0 & \end{cases}$

Change of origin → not affect on moments
change of scale → power of σ.

Moment Generation Function $M_X(t) = E(e^{tX})$

moment generating mgf

1st derivation mean 2^{nd} → variance at $t = 0$.

Weak law of large No:

weak law of large no

WLLN wlln

Let $X_1, X_2, X_3 \ldots X_n$ is a sequence of random variables and $\mu_1 \ldots \mu_n$ be means. and

$$B_n = Var(X_1 + X_2 \ldots X_n) \text{ is finite.}$$

Then $$P\left\{ \left| \frac{X_1 + X_2 + X_n}{n} - \frac{\mu_1 + \mu_2 + \mu_n}{n} \right| < c \right\} \geq \cancel{1-\eta}$$

english

Probality of averages converges to probability of their mean.

$$\frac{B_n}{n^2} \to 0 \quad , \text{ as } n \to \infty$$

CLT

→ $\boxed{\text{Central limit theorem:}}$

centeral central limit theorm

2 rules

(1) → The mean of samples means will be equal to population mean.

(2) → $S.D_{\text{sample mean}} < SD_{\text{population}}$

$$= \frac{SD \text{ population}}{\sqrt{\text{population size}}}$$

population

A population is collection of all items of interests to our study and is usually donoted by upper case N. The no we have obtained using population is called parameter.

sample

Sample → some section from whole population

Size of population = N

$$\mu \text{ (Mean)} = \frac{\Sigma X}{N}$$

$$\text{Variance} = \Sigma (X_i - \mu)^2 / N$$

distribution of sample means

→ Distribution of sample means is a distribution obtained by using the means computed from random samples of specific size taken from population

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sampling

Sampling Sometimes we may be able to decide types of probability distribution. but not the parameters (mean, variance, prob, median). so we rely on samples.

parameters

parameters → μ, σ^2 → Population

statistics

Statistics → $\bar{x}$, s → Sample

state

simple random sampling

Simple random sampling is a commonly used sampling plan in which every sample of size n has the same chance of being selected.

generalisation from sample to population is called Statistical Interference.

interference

Collect mean of various samples, group acc to freq and do sampling distribution of the mean.

standard error

The standard deviation of sampling distribution is called standard error.

If $n \geq 30$ large sample else small sample.

hypothesis

testing of hypo

Testing a hypothesis: To reach info about population on basis of sampling is called statical hypothesis, which may or may not be true.

Testing a hypothesis means deciding wather to accept or reject hypothesis.

Error

error

type1

1

Type 1: If hypo. is rejected, while it should have accepted.

type2

2

Type 2: hypo is accepted ——— rejected.

~~to reduce both error ↑ sample size~~

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→ we assume these are true, unless proved false

null
hypothesis

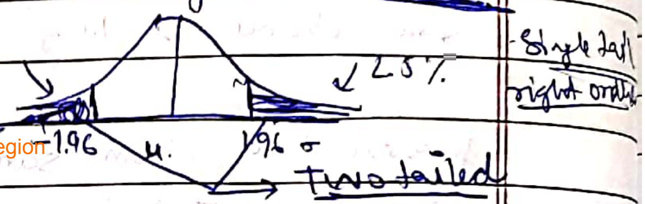
Null hypothesis : hypo. formulated for sake of rejecting it, under assumption it true.

By accepting null hypothesis, we mean that on basis of statistic calculated from sample, we don't reject it. but doesn't mean its true, Also rejection doesn't mean it disproved.

level of significance

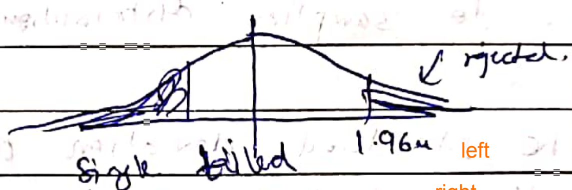
→ **Level of significance** :: The level below which we reject the hypothesis. The region is critical region.

~~1.96~~ → ~~5% level of sign~~ Critical region.



test of significance

→ **Test of significance** : Test which enables us to decide whether to accept or reject hypo.
We check b/w sample value and population value and their error.



two tailed

→ Two tailed ($H_2 \neq$)

Single tailed ($H_2 >, <$)

left
right
single tailed

level of significance	Two tailed	Single tailed
5%	→ 1.96μ.	→ 1.640%.
1%	→ 2.58	→ 2.33%.

confidence

Confidence limits : Tells how accurate your estimate of mean is likely to be.

Chi square Test : goodness of fit. chi square skip_if_you_are_looking for defination

The square of standard normal variate (Z) is known as chi square variate with 1 degree of freedom.

i.e If $X \sim N(\mu, \sigma^2)$ then $Z = \frac{(X-\mu)}{\sigma} \sim N(0,1)$

follows ↓ Normal distribution

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$$\chi^2 = \left(\frac{x-\mu}{\sigma}\right)^2$$ 1 degree of freedom

1 variable (x) is unknown

→ defination? do next

Find next.

$x_i \sim N(\mu_i, \sigma_i^2)$

$$\chi^2 = \sum_{i=1}^{n} \left(\frac{x_i-\mu_i}{\sigma_i}\right)^2 \quad n \text{ dof.}$$

Pdf →

chi square

$$p(\chi^2) = \frac{1}{2^{\nu/2}\,\Gamma\frac{\nu}{2}} e^{-\frac{\chi^2}{2}} (\chi^2)^{\frac{\nu}{2}-1}$$

where ν → degree of freedom | unknown variables.

Mean = ν Mode = $\nu - 2$

Variance = 2ν Skewness → $\sqrt{\frac{2}{\nu}}$

Chi Square Test is used for (Application)

→ goodness of fit.

→ independence of attributes etc.

→ To test if population has a specified value of σ^2

DEFINATION chi square defination

χ^2 afford a mesure of correspondence b/w theory and observation.

It describes the magnitude of dispency b/w theory and observate

eg: toss coin 100 time

expected | theory → 50 hea 50 tail observ 70 head, 30 tail

formula

$$\chi^2 = \sum_{i=1}^{n} \left[\frac{(O_i - E_i)^2}{E_i}\right].$$

formula

O_i → observed frequencies

E_i → theoritical frequencies

theory

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$\sum O_i = \sum E_i = N$

degree of freedom = $(n-1)$

$\chi^2 = 0$ → both frequency matches.

dof

degree of freedom

Degree of freedom = Total No of observation − (minus) (subtract) number of independent constraints imposed on observation.

conditions → chi square

Apply χ^2 test cond^n

(1) → $N \geq 50$ frequency ≥ 50

(3) No info of population → The constraints on cell frequencies should be linear.

(2) → $\sum E_i = \sum O_i$ and all $E_i, O_i > 5$

⇒ If calculated value of χ^2 is less than table value (generally 5%) of significance, fit is considered to be good (Null hypo is accepted) else reject

accept

reject

problems

Question Assume Null Hypothesis and find avg (mean) then do x_i − mean

→ i.e. $O_i - E_i$

Calculate χ^2

if χ^2 is less than 5% of table value for given d.o.f. Hypothesis is correct.

Test of Independence: We make Hypothesis that no two attributes are associated, and there is no association. [two attributes are associated or not] [We make contingency table]

if ~~χ^2 ≤ 5%~~ ~~of~~ χ^2 < table value of 5% of significance hypo is good.

contegency table

given

Contingency table

a	b
c	d

→

(1) $\frac{(a+b)(a+c)}{a+b+c+d}$	(2) $\frac{(b+a)(b+d)}{\ldots}$
(3) $\frac{(c+a)(c+d)}{(a+b+c+d)}$	(4)

$$\chi^2 = \frac{(a-1)^2}{1} + \frac{(b-2)^2}{2} \ldots$$

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Yates correction : is used ~~to~~ in certain situations when testing for independence by contigency table.

yates

It aims at correcting error introduced by assuming

correction

the discreate propabilities of frequency in table can be approximated by continous distribution

Ye add | subtract $1/2$ ~~from~~ to a and d.

sub | add $1/2$ ~~to~~ b and c

contigency table

a	b
c	d

Application | Use of Chi Test

applications chi square attributes

(1) Independence of attributes.

whether two attributes are reddated or not

we make contegency table.

independence

(2) ~~Good for fit.~~ good for fit

whether observed data matches theoritical data

(3) Test for homogenity → whether two proportions are equal or not. homogenity

interference

(4) Test of inference Assuming we know about population.

check if theorit variance = observe variance.

alternate

→ **Alternative. Hypo** → complementary to Null Hypo.

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Tests

tests

Hypothesis

Null — Alternative

* ~~Z Test~~

Null

↓ Testing

Statistical Test

parameters

parametric

- Parametric Test ← knows about population mean, median, skewness
  - Z Test
  - F Test
  - T Test
- Non-parametric Test
  - χ^2 – Test
  - U – Test
  - H – Test

last

end

T – test → testing the significance of difference of mean values when the sample size is small ~~the~~ & population standard deviation is not available.

t-test

ttest

Assume → Population dis → normal
→ Sample are small random & independent.
→ Population stand deviation is not known.

small

Z → Test determine weather the means ~~of~~ are different when a population variance is known.

z-test

It assume

ztest

→ Population dist → normal
→ sample → large, random, independen.
→ Population variance is known.

→ F-test ⇒ It is a test for the null hypothesis that two normal populations have same variance.

F-statistic = ratio of two variance

→ To test equality of means.

→ Normal population distri

→ random & independent samples.

f-test

ftest