

# STATISTICS

Statistics is a branch of Mathematics which deals with ~~two~~ <sup>the</sup> study of collection of data, tabulation of data and its analysis.

## Central Tendency

The tendency of statistical data to concentrate at the central value of data is called central tendency.

There are three measures of central tendency.

① Mean

② Mode

③ Median

Mean :- Mean means average. There are three methods for finding the mean of grouped data:-



Direct Method

$$\bar{x} = \frac{\sum f_i x_i}{\sum f_i}$$

Assumed Mean Method

$$\bar{x} = a + \frac{\sum f_i d_i}{\sum f_i}$$

~~Step Deviation Method~~

~~$$\bar{x} = a + h \left( \frac{\sum f_i v_i}{\sum f_i} \right)$$~~



# STATISTICS

Direct Method

$$\text{Mean} = \frac{\sum Fx}{\sum F}$$

$$\bar{x} = \frac{\sum fx}{\sum f}$$

Assumed mean method

Actual mean = Assumed Mean + Distributed

$$\bar{d} = \frac{\sum Fd}{\sum F}$$

$$\bar{d} = \frac{\sum F(x-a)}{\sum F}$$

$$\bar{d} = \frac{\sum Fx}{\sum F} - \frac{\sum Fa}{\sum F}$$

$$\bar{d} = \bar{x} - \frac{\sum Fa}{\sum F}$$

$$\bar{d} = \bar{x} - \frac{a \sum F}{\sum F}$$

$$\bar{d} = \bar{x} - a$$

$$\bar{x} = \bar{d} + a$$



## Step deviation method

$$\bar{u} = \frac{\sum Fu}{\sum f}$$

Here

$$u = \frac{x - a}{h}$$

$$\bar{u} = \frac{\sum f \left( \frac{x - a}{h} \right)}{\sum f}$$

$$\bar{u} = \frac{1}{h} \left[ \left( \frac{\sum fx}{\sum f} \right) - a \left( \frac{\sum f}{\sum f} \right) \right]$$

$$\bar{u} = \frac{1}{h} [\bar{x} - a]$$

$$x = a + h \bar{u}$$

$h$  = Class size

$a$  = Assumed median

Median

$$\text{Median} = d + \frac{(n/2 - cf)}{f} \times h$$

$d$  = Lower limit of median class

$n$  = no. of observation

$\sum f$  = Cumulative frequency

$f$  = Frequency



Cumulative frequency curve is called as Ogive

$$\frac{\sum f \cdot x}{N} = \bar{x}$$

Here

$$\sum f \cdot x = N \cdot \bar{x}$$

Slope of line =  $\frac{y_2 - y_1}{x_2 - x_1}$

$$\frac{N - f_1}{N} = \frac{N - f_2}{N}$$

$$\text{Mode} = \frac{L + (f_1 - f_0) \cdot h}{(2 \cdot f_1) - f_0 - f_2}$$

$$\bar{x} \approx \text{Mode}$$

L = Lower limit

h = class size

- $f_1$  = Frequency of modal class
- $f_0$  = preceding class
- $f_2$  = following class

$$3 \times \text{Median} = \text{Mode} + 2 \times \text{Mean}$$

$$3 \times \frac{(f_1 - f_0) \cdot h}{(2 \cdot f_1) - f_0 - f_2} + L = \text{Median}$$

2) Consider ----- a factory.  
 Find ----- method.

Assumed Mean (A) = 15  
 Class Interval (h) = 20

h	$f_i$	$x_i$	$u_i = (x_i - 150)/20$	$f_i u_i$
100-120	12	110	-2	-24
120-140	14	130	-1	-14
140-160	8	150	0	0
160-180	6	170	1	6
180-200	10	190	2	20
	$\Sigma f_i = 50$			$\Sigma f_i u_i = -12$

$$\text{Mean} = \bar{x} = A + h \frac{\Sigma f_i u_i}{\Sigma f_i}$$

$$= 150 + \left( 20 \times \frac{-12}{50} \right)$$

$$= 150 - 4.8$$

$$= 145.20$$

∴ Mean daily wage = ₹145.20

## Mode of Grouped Data / Distribution

Mode is that value of observation of statistical data having maximum frequency

$$\text{Mode} = l + \left( \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h$$

where,

$l$  = lower limit

$h$  = size of class interval

$f_1$  = frequency of modal class

$f_0$  = frequency of class preceding

$f_2$  = frequency of class succeeding



The following - - - - - tendency

$$\text{Modal class} = 35 - 45$$

$$l = 35$$

$$h = 10$$

$$f_m = 23$$

$$f_1 = 21$$

$$f_2 = 14$$

$$\text{Mode} = l + \left( \frac{f_m - f_1}{2f_m - f_1 - f_2} \right) \times h$$

$$= 35 + \left( \frac{23 - 21}{46 - 21 - 14} \right) \times 10$$

$$= 35 + \frac{20}{11}$$

$$= 35 + 1.8$$

$$= 36.8 \text{ yr}$$



## MEDIAN OF GROUP

Median is that value of observation which divides the data in two equal parts.

Median of grouped data is given by the formula

$$\text{Median} = l + \left( \frac{\frac{n}{2} - cf}{f} \right) \times h$$

$l$  = lower limit of median class

$n$  = no. of observations

$cf$  = cumulative frequency

$f$  = frequency

$h$  = class size



1] The following --- --- --- them.

Monthly consumption	cf	No. of consumers
65 - 85	4	4
85 - 105	9	5
105 - 125	<sup>cf</sup> 22	13
<b>125 - 145</b>	42	<b>20</b> f
145 - 165	56	14
165 - 185	64	8
185 - 205	68	4
		$\Sigma n = 68$

$$\frac{n}{2} = \frac{68}{2} = 34$$

125 - 145 is median class

$$\text{Median class} = l + \left( \frac{n/2 - cf}{f} \right) \times h$$

$$= 125 + \left( \frac{34 - 22}{20} \right) \times 20$$

$$= 125 + \left( \frac{12}{20} \right) \times 20$$

$$= 137$$



Monthly consumption	No. of consumers
65 - 85	4
85 - 105	5
105 - 125	13 $f_0$
125 - 145	20 $f_1$
145 - 165	14 $f_2$
165 - 185	8
185 - 205	4

$$\text{Mode} = l + \left( \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h$$

$$= 125 + \left( \frac{20 - 13}{2(20) - 13 - 14} \right) \times 20$$

$$= 125 + \left( \frac{7}{40 - 27} \right) \times 20$$

$$= 125 + \left( \frac{7}{13} \right) \times 20$$

$$= 125 + \frac{140}{13}$$

$$= 125 + 10.76$$

$$= 135.76$$

Relationship between three measures of  
Central Tendency

$$3 \times \text{Median} = \text{Mode} + 2 \times \text{Mean}$$



of the following expenditure -

Expenditure	$f_1$	$xf_1$	$f_2$	$xf_2$	$cf$	$fxi$
1000 - 1500	24	1250	-3	-72	24	-72
1500 - 2000	40	1750	-2	-80	64	-152
2000 - 2500	33	2250	-1	-33	97	-185
2500 - 3000	28	2750	0	0	125	-185
3000 - 3500	30	3250	1	30	155	-155
3500 - 4000	22	3750	2	44	177	-111
4000 - 4500	16	4250	3	48	193	-48
4500 - 5000	7	4750	4	28	200	-28

$$\sum f_1 = 200$$

$$\sum f_{xi} = -35$$

Modal class = 1500 - 2000

$$l = 1500$$

$$f_m = 40, f_1 = 24, f_2 = 33, b = 500$$

$$\text{Mode} = l + \left( \frac{f_m - f_1}{2f_m - f_1 - f_2} \right) \times h$$

$$\text{Mode} = 1500 + \left( \frac{40 - 24}{80 - 24 - 33} \right) \times 500$$

$$\text{Mode} = 1500 + \left( \frac{16 \times 500}{23} \right)$$

$$\text{Mode} = 1500 + \frac{8000}{23}$$

$$= 1500 + 347.83$$

∴ Modal expenditure of families = ₹1847.83

Let A = 2750

$$\text{Mean} = \bar{x} = A + \left( \frac{\sum f_i x_i}{\sum f_i} \right) \times h$$

$$= 2750 + \left( \frac{-35}{200} \right) \times 500$$

$$\Rightarrow 2750 - 87.50$$

$$= 2662.50$$

Q] The following — — — — — measures

→ Class Interval	f <sub>i</sub>	x <sub>i</sub>	f <sub>i</sub> x <sub>i</sub>
15-20	3	17.5	52.5
20-25	8	22.5	180.0
25-30	9	27.5	247.5
30-35	10	32.5	325.0
35-40	3	37.5	112.5
40-45	0	42.5	0
45-50	0	47.5	0
50-55	2	52.5	105.0
	$\Sigma f_i = 35$		$\Sigma f_i x_i = 1022.5$