1. Introduction

Welcome to the series on E-Learning module in Mode, Median and Partition values (part I). In this session, we are going to discuss how to calculate Median and Partition values.

By the end of this session, you will be able to:

- Calculation median in the following cases:
 - Individual series (both odd & even series), discrete series, continuous series
 - o Inclusive series
 - Open end classes
 - Cumulative frequency
 - Missing frequencies
 - Mid value classes
 - Unequal class interval
- Calculate partition values like Quartiles, Deciles and Percentiles

Median is a positional average, which is widely used in statistical analysis. It refers to the middle value of a distribution when the series is arranged in ascending or descending order. In other words, median is a value, which divides the series into two equal parts.

Let us see the Calculation of median in case of Individual Series or Observation:

A series is differentiated as odd series or even series depending on the number of items in the series. Therefore, when calculating the median we will have to arrange the data in ascending or descending order.

Odd number series: Problem 1: Calculate the value of median from the following figures:

X	145	300	42	250	75	101	210	175	85
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Arrange the given data in ascending order.

Figure 2

X	42	75	85	101	145	175	210	250	300
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Then, we will apply the formula median is equal to size of N plus 1 divided by 2th item. Here n is equal to 9 so the median will be 9 plus 1 divided by 2th item which is equal to 10 divided by 2th item which is equal to the 5th item.

The 5^{th} item in this data is 145, so the median is equal to 145.

Even number series: Problem 2: From the following figures, calculate the median.

Figure	3
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Arrange the given data in ascending order.

Figure 4

Wages(Rs.)	180	200	220	260	280	320	360	400
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Then, we will apply the formula median is equal to size N plus 1 divided by 2th item. Here, N is equal to 8 so the median will be 8 plus 1 divided by 2th item which is equal to 9 divided by 2th item which is equal to 4.5^{th} item. The 4.5^{th} item is the average of the 4^{th} item and the 5^{th} item. So we will take the average of the item 260 + 280 divided by 2 is equal to 540 divided by 2 which is equal to Rs. 270. Thus the median wage is equal to Rs.270/-.

2. Calculation of median in case of Discrete series – Part 1

Calculation of median in case of Discrete series Problem 3

Determine the median from the following data:

Figure 5

Size	105	110	115	120	125	130	135
Frequency	2	3	4	6	10	5	2

First arrange the data in ascending order, then we will calculate the cumulative frequency, they are 2, 5, 9, 15, 25, 30 and 32.

Figure 6

Size	Frequency	Cumulative Frequency (Cf)
105	2	2
110 3		2+3 = 5
115	4	2+3+4 = 9
120	6	2+3+4+6 = 15
125	10	2+3+4+6+10 = 25
130	5	2+3+4+6+10+5 = 30
135	2	2+3+4+6+10+5+2 = 32

Let us now use the formula and calculate the median item of the series. Median is equal to N plus 1 divided by 2th item. N is calculated by adding the total of the frequency which is equal to 32 plus 1 divided by 2 is equal to 33 divided by 2 which are equal to 16.5th item. Size of the 16.5th item is equal to 125.

Here the cumulative frequency that is equal to or greater than 16.5 is the cumulative

frequency 25 and the corresponding variable is 125. Hence, the median of the given data is equal to 125.

Calculation of median in case of Continuous series.

Figure 7

Variable (X)	0-5	5-10	10-15	15-20	20-25
Frequency	44	60	36	44	8

Problem 4 Compute the median from the following series.

Let us first calculate the cumulative frequency by adding up the frequencies, so that we will get 44, 104, 140, 184 and 192.

Size Frequency		Cumulative Frequency (Cf)
0-5	44	44
5-10	60	44+60 = 104
10-15	36	44+60+36 = 140
15-20	44	44+60+36+44 = 184
20-25	8	44+60+36+44+8 = 192

Now let us apply the formula and find the median class using N divided by 2. Here N is equal to the total of frequency that is 192. Therefore, the median class is equal to 192 divided by 2, which are equal to 96th item, which lies in 5-10 groups. Therefore, the median class is equal to 5-10.

Let us now interpolate the value of the median using the median class by using the formula: Median is equal to lone plus N by 2 minus cf whole divided by f into c. The values are: 11 is the lower limit of the class interval and is equal to 5, N/2 is the size of the item that is 96th item, cf is the cumulative frequency of the preceding class which is equal to 44, f is the frequency of the median class which is equal to 60 and c width of the class interval which is equal to 5. When these values are substituted and calculated, we get the median as 9.333.

Calculation of median in case of Inclusive series:

Problem 5

Find the median from the following data.

Wages	50-69	70-89	90-109	110-129	130-159
No. of workers	18	75	21	10	41

First, convert the inclusive series to exclusive series by adding the correction factor point 5 to the upper limit and deducting it from the lower limit. We will get the new set of class intervals as 49.5-69.5, 69.5-89.5, 89.5-109.5, 109.5-129.5, and 129.5-159.5. Now add the frequencies to get the cumulative frequency as 18, 93, 114, 124, and 165. Let us now calculate the median class using N divided by 2 which is equal to 165th item divided by 2 is equal to 82.5th item. The median class will be 69.5-89.5.

Fia	ure	10

Size	Frequency	Cf
49.5-69.5	18	18
69.5-89.5	75	93
89.5-109.5	21	114
109.5-129.5	10	124
129.5-159.5	41	165

Now we will interpolate the median using the formula: Median is equal to lone plus N by 2 minus cf whole divided by f into c. The values are I1 is the lower limit of the class interval = 69.5, N/2 is the size of the item 82.5th item, cf is the cumulative frequency of the preceding class which is equal to 18, f is the frequency of the median class which is equal to 75 and c width of the class interval is equal to 20. When these values are substituted and calculated we get the median as 86.7. Thus, the median wage is equal to Rs. 86.7.

Calculation of median in case of Open end classes.

Wages (Rs) Below	10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90- 100	100& above
No. Of workers	1	16	38	58	60	46	22	15	15	7	12

Problem 6 From the following distribution of wages, locate the median.

Let us first identify the lower limit of the first class and the upper limit of the last class so we will get the class intervals as 0-10, 10-20, 20-30 and so on until the last class interval 100-110. Now, calculate the cumulative frequency we will get 1, 17, 55, 113, 173, 219, 241, 256, 271, 278 and 290. Now, identify the median class using the formula N divided by 2 is equal to 290 divided by 2, which is equal to 145th item, which lies in the group 40-50. Thus, the median class is equal to 40-50.

Wages	Workers	Cf
0-10	1	1
10-20	16	17
20-30	38	55
30-40	58	113
40-50	60	173
50-60	46	219
60-70	22	241
70-80	15	256
80-90	15	271
90-100	7	278
100-110	12	290

Now, we will interpolate the median value by using the Median is equal to lone plus N by 2 minus cf whole divided by f into c. The values are I1 is the lower limit of the class interval which is 40, N/2 is the size of the item that is 145th item, cf is the cumulative frequency of the preceding class which is equal to 113, f is the frequency of the median class which is equal to 60 and c is the width of the class interval which is equal to 10. When these values are substituted and calculated we get the median as 45.333. Thus, the median wage is equal to Rs. 45.333.

3. Calculation of median – Part 2

Calculation of median in case of Cumulative frequency:

Problem 7:

In a bank, the following were the deposits of current account during January 2012. Calculate the median.

Deposit Balance (<)	1000	900	800	600	550	500	400	250	100
No. of deposits	480	478	460	455	420	354	280	105	5

It is a case of cumulative frequency, so it is necessary to convert it into simple frequency distribution. Also the classes are given in descending order. They are to be rearranged in ascending order, so the new set of data will be as follows with the arranged class intervals from 0-100, 100-250, till 900-1000. The simple frequencies are calculated by taking the difference between the frequencies so that we will get 5, 100, 175, 74, 66, 35, 5, 18 and 2. Now calculate the cumulative frequency we will get 5, 105, 280 and so on.

Now identify the median class using the formula N divided by 2 which is 480 divided by 2 is equal to 240th item, which lies in the group 250-400. Thus, the median class is equal to 250-400.

Fia	ure	14
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Deposit	No. of deposits	Cf
0-100	5	5
100-250	100	105
250-400	175	280
400-500	74	354
500-550	66	420
550-600	35	455
600-800	5	460
800-900	18	478
900-1000	2	480

Now we will interpolate the median value by using the formula: Median is equal to lone plus N by 2 minus cf whole divided by f into c. The values are I1 is the lower limit of the class interval which is equal to 250, N/2 is the size of the item that is 240th item, cf is the cumulative frequency of the preceding class which is equal to 105, f is the frequency of the median class which is equal to 175 and c is the width of the class interval which is equal to 150. When these values are substituted and calculated we get the median as 365.714. Thus, the median wage is equal to Rs. 365.714.

Calculation of median in case of Missing frequencies:

Problem 8:

Find the missing frequency in the group 20-30 when the median is given to be 28.

X	0-10	10-20	20-30	30-40	40-50
f	5	8	?	16	6

Let us calculate the cumulative frequency, we will get 5, 13, 13+A, 29+A, 35+A. The median value is already given as 28. Thus, the median class is equal to 20-30.

x	f	Cf
0-10	5	5
10-20	8	13
20-30	А	13 +A
30-40	16	29+ A
40-50	6	35 + A

Now we will interpolate the median value by using the formula: Median is equal to lone plus N by 2 minus cf whole divided by f into c. The values are 11 is the lower limit of the class interval which is equal to 20, N/2 is the size of the item that is 35+A/2th item, cf is the cumulative frequency of the preceding class which is equal to 13, f is the frequency of the median class which is equal to A and c is the width of the class interval which is equal to 10. When these values are substituted we get 28 is equal to 20 plus 35+A minus 13 divided by A into 10, we will get 28-20 is equal to 35+A/2 minus 13 divided by A into c which is equal to 8A is equal to 35+A -26 divided by 2 into 10 which is equal to 16A is equal to 9+A into 10 is equal to 16A-10A is equal to 90, 6A is equal to 90, A is equal to 90 divided by 6 which is equal to 15. Hence, we have calculated the value of the missing frequency as 15.

Calculation of median in case of Mid value classes: Problem 9:

Compute the median from the following data:

Mid value	5	15	25	35	45	55	65	75
Frequency	15	7	11	10	13	8	20	16

As the mid values are given, let us first calculate the class size. We can get the class size by applying the formula, lower limit is equal to mid value minus difference of the mid value divided by 2 and the upper limit is equal to mid value plus the difference of the mid value divided by 2. Thus, the class size calculated are 0-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80. On calculating the cumulative frequency, we will get 15, 22, 33, 43, 56, 64, 84 and 100. Now identify the median class using the formula N divided by 2 is equal to 100 divided by 2, which is equal to 50^{th} item, which lies in the group 40-50. Thus, the median class is equal to 40-50.

Class Interval	frequency	Cf
0-10	15	15
10-20	7	22
20-30	11	33
30-40	10	43
40-50	13	56
50-60	8	64
60-70	20	84
70-80	16	100

Now we will interpolate the median value by using the formula: Median is equal to lone plus N by 2 minus cf whole divided by f into c. The values are I1 is the lower limit of the class interval which is equal to 40, N/2 is the size of the item that is 50th item, cf is the cumulative frequency of the preceding class which is equal to 43, f is the frequency of the median class which is equal to 13 and c is the width of the class interval which is equal to 10. When these values are substituted and calculated we will get the median as 45.385.

4. Calculation of median in case of Unequal class interval

Calculation of median in case of Unequal class interval;

In calculating median of unequal class intervals, the adjustment of class interval is not required. The median is calculated as is done in the case of equal class intervals.

Figure 19

Class	0-3	3-6	6-10	10-12	12-15	15-20
Frequency	4	8	10	14	16	20

Problem 10: Compute the median from the following data:

Let us calculate the cumulative frequency; we will get 4, 12, 22, 36, 52 and 72. Now identify the median class using the formula N divided by 2 is equal to 72 divided by 2 is equal to 36th item which lies in the group 10-12. Thus, the median class is equal to 10-12.

Class Interval	frequency	Cf
0-3	4	4
3-6	8	12
6-10	10	22
10-12	14	36
12-15	16	52
15-20	20	72

Now we will interpolate the median value by using the formula: Median is equal to lone plus N by 2 minus cf whole divided by f into c. The values are I1 is the lower limit of the class interval is equal to 10, N/2 is the size of the item that is 36th item, cf is the cumulative frequency of the preceding class which is equal to 22, f is the frequency of the median class which is equal to 14 and c is the width of the class interval which is equal to 2. When these values are substituted and calculated we get the median as 12.

Partition Values

Partition values are values, which divide the data into four parts, ten parts and hundred parts. These measures are called as quartiles, deciles and percentiles. Let us calculate these values for all the three series.

Calculation of quartiles, deciles and percentiles in Individual series:

Problem 11: From the following determine Q_1 , Q_3 , D_5 and P_{25} Marks in statistics paper: 15, 21, 26, 30, 40, 45, 50, 54, 60, 65, 70

Let us calculate the first and the third quartile by using the formula Q_1 is equal to N plus 1 divided by 4th item. There are 11 items so Q_1 is equal to 11 plus 1 divided by 4 is equal to 12 divided by 4 which is equal to the 3rd item. Therefore, the third item is 26.

Calculation of Q_3 is equal to 3N plus 1 by 4 is equal to the size of the 9th item which is equal to 60.

As decile divides the data into ten parts we calculate D₅ is equal to 5 into N plus 1 by 10th item

is equal to the 6th item, which is equal to 45.

Percentile divides the data into 100 parts. We calculate P_{25} is equal to 25 into N plus 1 by 100 is equal to the 3rd item is equal to 26. Thus, $Q_1=26$, $Q_3=60$, $D_5=45$ and $P_{25}=26$.

Calculation of quartiles, deciles and percentiles in discrete series: Problem 12:

From the following, compute Q_1 , Q_3 , D_3 and $P_{70.}$

Figure 21

X	10	20	30	40	50	60	70
f	2	3	5	10	5	3	2

Let us calculate the cumulative frequency of the given data; they are 2, 5, 10, 20, 25, 28 and 30.

X	f	Cumulative frequency	
10	2	2	
20	3	2+3=5	
30	5	5+5=10	
40	10	10+10=20	
50	5	20+5=25	
60	3	25+3=28	
70	2	28+2=30	

Let us calculate the first and the third quartile by using the formula Q_1 is equal to N plus 1 divided by 4 th item. There are 30 items so Q_1 is equal to 30 plus 1 divided by 4 is equal to 31 divided by 4 is equal to the 7.75th item, which is equal to 10 in the cumulative frequency which is equal to 30.

Calculation of Q_3 is equal to 3N plus 1 by 4 is equal to the size of the 23.25th item which is equal to 25 in the cumulative frequency and is equal to 50.

As decile divides the data into ten parts we calculate D_3 is equal to 3 into N plus 1 by 10 item is equal to the 9.3rd item, which is equal to 30.

Percentile divides the data into 100 parts we calculate P_{70} is equal to 70 into N plus 1 by 100 is equal to the 21.7th item which is equal to 50.

Figure 22

5. Calculation of quartiles, deciles and percentiles – Part 2

Calculation of quartiles, deciles and percentiles in Continuous series:

Problem 13: From the following, compute Q_1 , Q_3 , D_6 and P_{80} .

Figure 23

Age	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60
No. of People	60	80	90	150	180	130	140	60

Let us calculate the cumulative frequency of the given data. They are 60, 140, 230, 380, 560, 690, 830 and 890. In all the cases, first we will identify the classes and then interpolate the value using the formula.

Size	Frequency	Cumulative Frequency (Cf)
20-25	60	60
25-30	80	140
30-35	90	230
35-40	150	380
40-45	180	560
45-50	130	690
50-55	140	830
55-60	60	890

Let us calculate the first quartile and the third quartile. The first quartile is equal to N divided by 4 is equal to 890 divided by 4 is equal to 222.5th item which falls in 30-35 group.

Let us interpolate the value of Q1 using the formula: Q1 is equal to I one plus N by 4 minus cf whole divided by f into c. The values are, I1 is the lower limit of the class interval which is equal to 30, N/4 is the size of the item that is 222.5th item, cf is the cumulative frequency of the preceding class which is equal to 140, f is the frequency of the quartile class which is equal to 90 and c is the width of the class interval which is equal to 5. When these values are substituted and calculated we get the first quartile as 34.583.

The third quartile is equal to 3N divided by 4 is equal to3 into 890 divided by 4 is equal to 667.5th item which falls in 45-50 group.

Let us interpolate the value of Q3 using the formula: Q3 is equal to I one plus 3 into N by 4 minus cf whole divided by f into c. The values are I1 is the lower limit of the class interval which is equal to 45, 3(N/4) is the size of the item that is 667.5th item, cf is the cumulative frequency of the preceding class which is equal to 560, f is the frequency of the quartile class which is equal to 130 and c is the width of the class interval which is equal to 5. When these values are substituted and calculated we get the third quartile as 49.135.

The sixth decile is equal to 6 into N divided by 10 is equal to 6 into 890 divided by 10 is equal to 534th item falls in 40-45 group.

Let us interpolate the value of D6 using the formula: D6 is equal to I one plus 6 into N by 10 minus cf whole divided by f into c, where in the values are I1 is the lower limit of the class interval which is equal to 40, 6N/4 is the size of the item 534th item, cf is the cumulative

frequency of the preceding class which is equal to 380, f is the frequency of the quartile class which is equal to 180 and c is the width of the class interval which is equal to 5. When these values are substituted and calculated we get the first quartile as 44.278.

The eightieth percentile is equal to 80 N divided by 100 is equal to 80 into 890 divided by 100 is equal to 712th item which falls in 50-55 group.

Let us interpolate the value of P80 using the formula: P80 is equal to I one plus 80 into N by 100 minus cf whole divided by f into c. The values are I1 is the lower limit of the class interval which is equal to 50, 80N/100 is the size of the item that is 712th item, cf is the cumulative frequency of the preceding class which is equal to 690, f is the frequency of the percentile class which is equal to 140 and c is the width of the class interval which is equal to 5. When these values are substituted and calculated we get the eightieth percentile as 50.786. In this session we have understood:

- The calculation of median done in the following cases:
 - Individual series both odd & even series)
 - Discrete series
 - Continuous series
 - Inclusive series
 - Open end classes
 - Cumulative frequency
 - Missing frequencies, Mid value classes
 - Unequal class interval
- The calculation of the partition values