BUSINESS ANALYTICS

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EXAMPLE 2.3: BASEBALL SALARIES 2011.XLSX

	A	B	C	D	E	F
1	**Measures of central tendency**				**Measures of variability**	
2	Mean	$3,305,055			Range	$31,586,000
3	Median	$1,175,000			Interquartile range	$3,875,925
4	Mode	$414,000	57		Variance	20,563,887,478,833
5					Standard deviation	$4,534,742
6	**Min, max, percentiles, quartiles**				Mean absolute deviation	$3,249,917
7	Min	$414,000				
8	Max	$32,000,000			**Measures of shape**	
9	P01	$414,000	0.01		Skewness	2.2568
10	P05	$414,000	0.05		Kurtosis	5.7233
11	P10	$416,520	0.10			
12	P20	$424,460	0.20		**Percentages of values less than given values**	
13	P50	$1,175,000	0.50		Value	Percentage less than
14	P80	$5,500,000	0.80		$1,000,000	46.38%
15	P90	$9,800,000	0.90		$1,500,000	54.69%
16	P95	$13,590,000	0.95		$2,000,000	58.36%
17	P99	$20,000,000	0.99		$2,500,000	63.23%
18	Q1	$430,325	1		$3,000,000	66.55%
19	Q2	$1,175,000	2			
20	Q3	$4,306,250	3			

MEASURES OF VARIABILITY

- THE **RANGE** IS THE MAXIMUM VALUE MINUS THE MINIMUM VALUE.
- THE **INTERQUARTILE RANGE** (**IQR**) IS THE THIRD QUARTILE MINUS THE FIRST QUARTILE.
  - THUS, IT IS THE RANGE OF THE MIDDLE 50% OF THE DATA.
  - IT IS LESS SENSITIVE TO EXTREME VALUES THAN THE RANGE.
- THE **VARIANCE** IS ESSENTIALLY THE AVERAGE OF THE SQUARED DEVIATIONS FROM THE MEAN.
  - IF X_I IS A TYPICAL OBSERVATION, ITS SQUARED DEVIATION FROM THE MEAN IS $(X_I - MEAN)^2$.

MEASURES OF VARIABILITY

- THE **SAMPLE VARIANCE** IS DENOTED BY S^2, AND THE **POPULATION VARIANCE** BY σ^2.

$$s^2 = \frac{\sum_{i=1}^{n} (X_i - \text{mean})^2}{n - 1}$$

$$\sigma^2 = \frac{\sum_{i=1}^{n} (X_i - \text{mean})^2}{n}$$

  - IF ALL OBSERVATIONS ARE CLOSE TO THE MEAN, THEIR SQUARED DEVIATIONS FROM THE MEAN—AND THE VARIANCE—WILL BE RELATIVELY SMALL.
  - IF AT LEAST A FEW OF THE OBSERVATIONS ARE FAR FROM THE MEAN, THEIR SQUARED DEVIATIONS FROM THE MEAN—AND THE VARIANCE—WILL BE LARGE.
  - IN EXCEL, USE THE *VAR* FUNCTION TO OBTAIN THE SAMPLE VARIANCE AND THE *VARP* FUNCTION TO OBTAIN THE POPULATION VARIANCE.

MEASURES OF VARIABILITY

- A FUNDAMENTAL PROBLEM WITH VARIANCE IS THAT IT IS IN SQUARED UNITS (E.G., $ → $^{2}).
- A MORE NATURAL MEASURE IS THE **STANDARD DEVIATION**, WHICH IS THE SQUARE ROOT OF VARIANCE.
  - THE **SAMPLE STANDARD DEVIATION**, DENOTED BY *S*, IS THE SQUARE ROOT OF THE SAMPLE VARIANCE.
  - THE **POPULATION STANDARD DEVIATION**, DENOTED BY *Σ*, IS THE SQUARE ROOT OF THE POPULATION VARIANCE.
  - IN EXCEL, USE THE *STDEV* FUNCTION TO FIND THE SAMPLE STANDARD DEVIATION OR THE *STDEVP* FUNCTION TO FIND THE POPULATION STANDARD DEVIATION.

	A	B	C	D	E	F
1	**Low variability supplier**				**High variability supplier**	
2						
3	Diameter1	Sq dev from mean			Diameter2	Sq dev from mean
4	102.61	6.610041			103.21	9.834496
5	103.25	10.310521			93.66	41.139396
6	96.34	13.682601			120.87	432.473616
7	96.27	14.205361			110.26	103.754596
8	103.77	13.920361			117.31	297.079696
9	97.45	6.702921			110.23	103.144336
10	98.22	3.308761			70.54	872.257156
11	102.76	7.403841			39.53	3665.575936
12	101.56	2.313441			133.22	1098.657316
13	98.16	3.530641			101.91	3.370896
14						
15	Mean				Mean	
16	100.039				100.074	
17						
18	Sample variance				Sample variance	
19	9.1098	9.1098			736.3653	736.3653
20						
21	Population variance				Population variance	
22	8.1988	8.1988			662.7287	662.7287
23						
24	Sample standard deviation				Sample standard deviation	
25	3.0182	3.0182			27.1361	27.1361
26						
27	Population standard deviation				Population standard deviation	
28	2.8634	2.8634			25.7435	25.7435

EMPIRICAL RULES FOR INTERPRETING STANDARD DEVIATION

- THE INTERPRETATION OF THE STANDARD DEVIATION CAN BE STATED AS THREE **EMPIRICAL RULES**.
  - IF THE VALUES OF A VARIABLE ARE APPROXIMATELY *NORMALLY* DISTRIBUTED (SYMMETRIC AND BELL-SHAPED), THEN THE FOLLOWING RULES HOLD:
    - APPROXIMATELY 68% OF THE OBSERVATIONS ARE WITHIN ONE STANDARD DEVIATION OF THE MEAN.
    - APPROXIMATELY 95% OF THE OBSERVATIONS ARE WITHIN TWO STANDARD DEVIATIONS OF THE MEAN.
    - APPROXIMATELY 99.7% OF THE OBSERVATIONS ARE WITHIN THREE STANDARD DEVIATIONS OF THE MEAN.

EMPIRICAL RULES FOR BASEBALL SALARIES
(SLIDE 2 OF 3)

- THE EMPIRICAL RULES SHOULD BE APPLIED WITH CAUTION, ESPECIALLY WHEN THE DATA ARE CLEARLY SKEWED, AS ILLUSTRATED BY THE CALCULATIONS FOR BASEBALL SALARIES BELOW.

	H	I	J	K	L	M	N	O
1	**Do empirical rules apply?**							
2		Lower endpoint	Upper endpoint	# below lower	# above upper	% below lower	% above upper	% between
3	Rule 1	-$1,229,688	$7,839,797	0	108	0%	13.20%	86.80%
4	Rule 2	-$5,764,430	$12,374,539	0	54	0%	6.60%	93.40%
5	Rule 3	-$10,299,172	$16,909,281	0	19	0%	2.32%	97.68%

MEASURES OF SHAPE

(SLIDE 1 OF 2)

- **SKEWNESS** OCCURS WHEN THERE IS A LACK OF SYMMETRY.
  - A VARIABLE CAN BE **SKEWED TO THE RIGHT** (OR **POSITIVELY SKEWED**) BECAUSE OF SOME REALLY *LARGE* VALUES (E.G., REALLY LARGE BASEBALL SALARIES).
  - OR IT CAN BE **SKEWED TO THE LEFT** (OR **NEGATIVELY SKEWED**) BECAUSE OF SOME REALLY *SMALL* VALUES (E.G., TEMPERATURE LOWS IN ANTARCTICA).
- IN EXCEL, A MEASURE OF SKEWNESS CAN BE CALCULATED WITH THE *SKEW* FUNCTION.

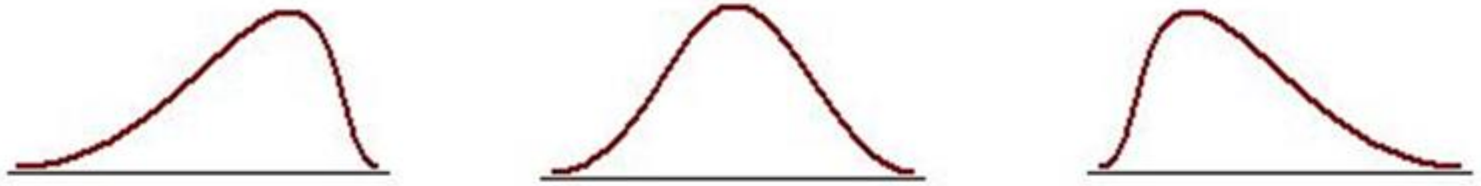
MEASURES OF SHAPE
(SLIDE 2 OF 2)

- **KURTOSIS** HAS TO DO WITH THE “FATNESS” OF THE TAILS OF THE DISTRIBUTION RELATIVE TO THE TAILS OF A NORMAL DISTRIBUTION.
- A DISTRIBUTION WITH HIGH KURTOSIS HAS MANY MORE EXTREME OBSERVATIONS.
- IN EXCEL, KURTOSIS CAN BE CALCULATED WITH THE *KURT* FUNCTION.

SKEWNESS

Skewness

The coefficient of Skewness is a measure for the degree of symmetry in the variable distribution.

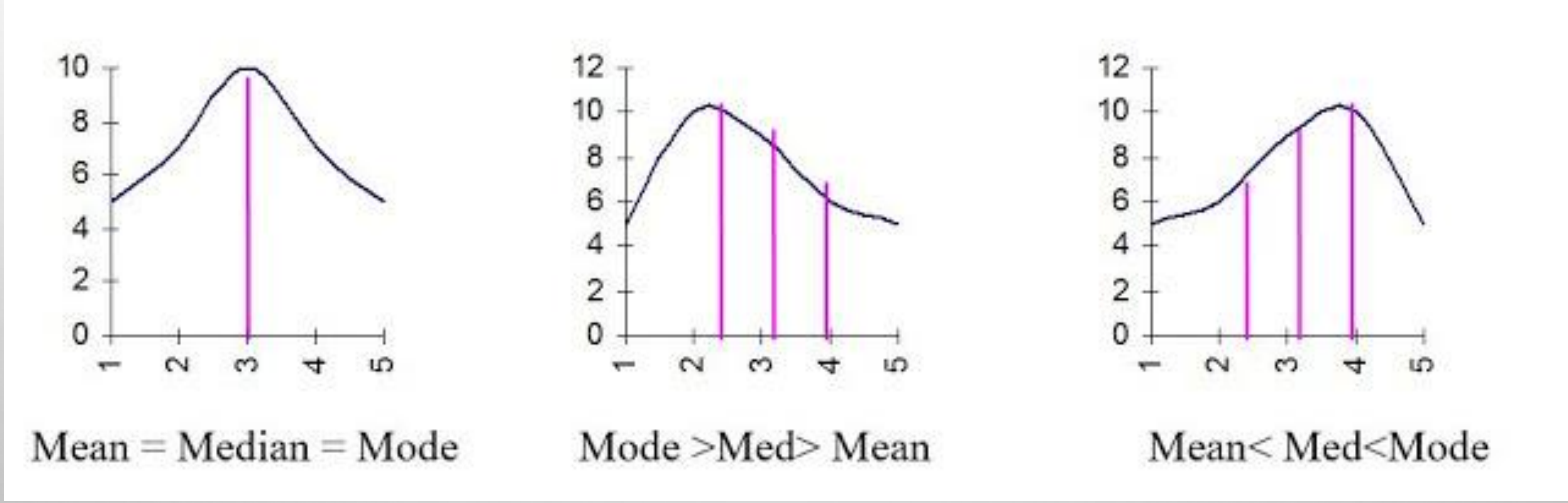


Negatively skewed distribution
or Skewed to the left
Skewness <0

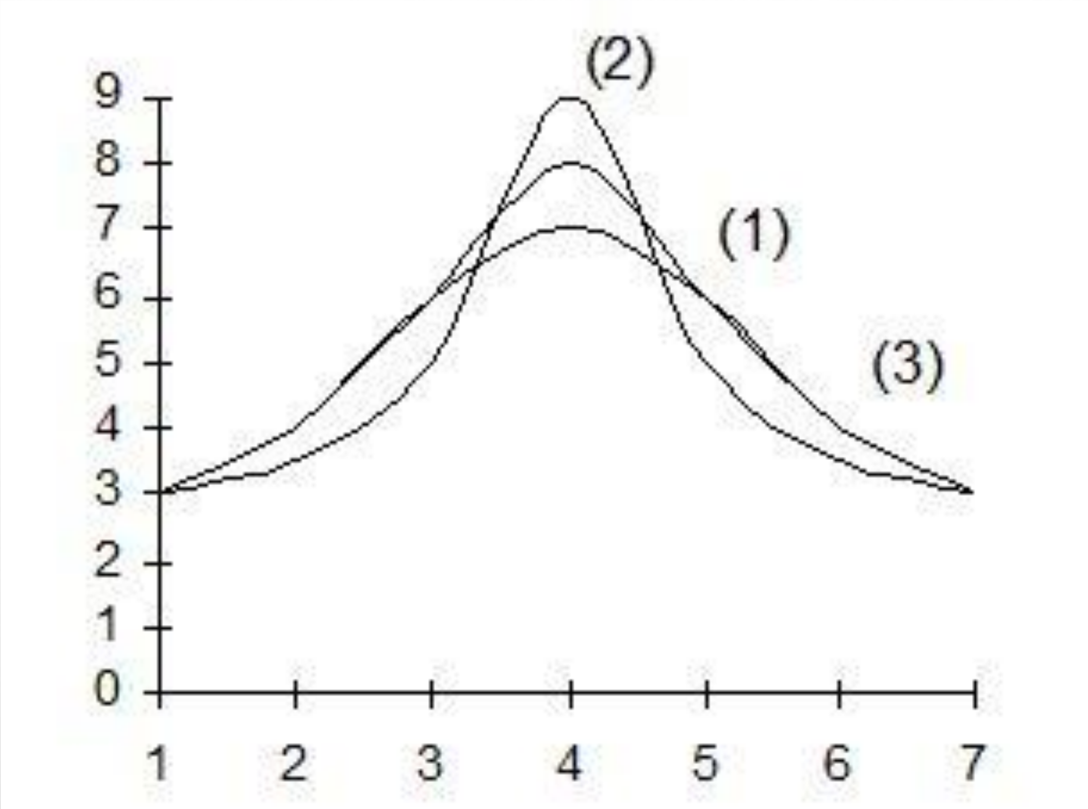
Normal distribution
Symmetrical
Skewness = 0

Positively skewed distribution
or Skewed to the right
Skewness > 0

SYMMETRY



10
8
6
4
2
0
1
2
3
4
5
Mean = Median = Mode
12
10
8
6
4
2
0
1
2
3
4
5
Mode >Med> Mean
12
10
8
6
4
2
0
1
2
3
4
5
Mean< Med<Mode



KURTOSIS

- CURVE 1 IS NORMAL
- CURVE 2 IS A LEADING CURVE
- CURVE 3 IS A FLAT CURVE

- ALL THREE ARE SYMMETRICAL AROUND THE MEAN.

CHARTS FOR NUMERICAL VARIABLES

- THERE ARE MANY GRAPHICAL WAYS TO INDICATE THE DISTRIBUTION OF A NUMERICAL VARIABLE.
  - FOR CROSS-SECTIONAL VARIABLES:
    - HISTOGRAMS
    - BOX PLOTS
  - FOR TIME SERIES VARIABLES:
    - TIME SERIES GRAPHS

HISTOGRAMS

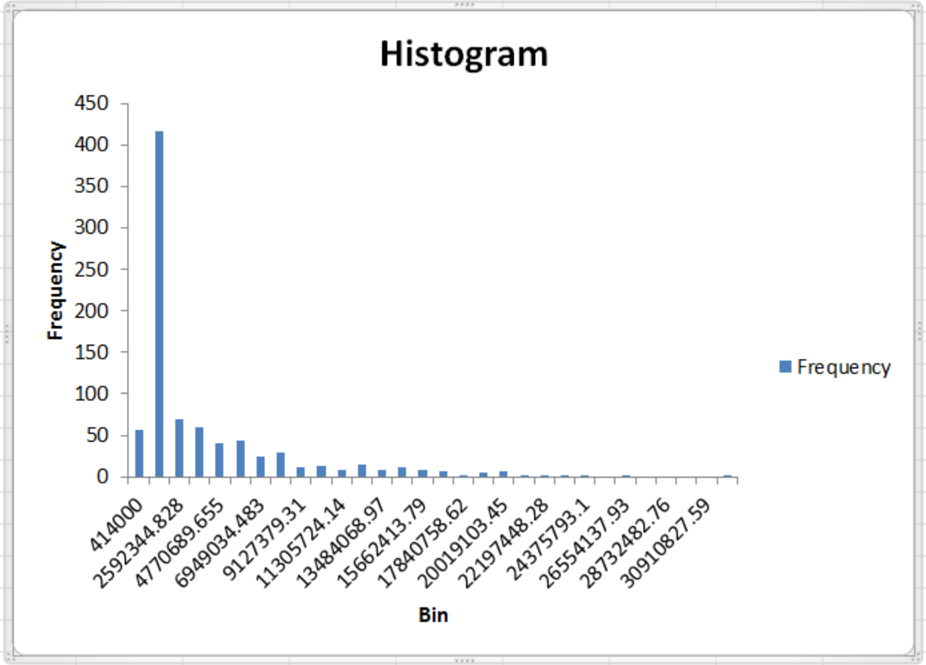
- A **HISTOGRAM** IS THE MOST COMMON TYPE OF CHART FOR SHOWING THE DISTRIBUTION OF A NUMERICAL VARIABLE.
  - IT IS BASED ON BINNING THE VARIABLE—THAT IS, DIVIDING IT UP INTO DISCRETE CATEGORIES.
  - IT IS A COLUMN CHART OF THE COUNTS IN THE VARIOUS CATEGORIES (WITH NO GAPS BETWEEN THE VERTICAL BARS).
- A HISTOGRAM IS GREAT FOR SHOWING THE SHAPE OF A DISTRIBUTION—WHETHER THE DISTRIBUTION IS SYMMETRIC OR SKEWED IN ONE DIRECTION.

BASEBALL SALARIES 2011.XLSX

- **OBJECTIVE:** TO SEE THE SHAPE OF THE SALARY DISTRIBUTION THROUGH A HISTOGRAM.
- **SOLUTION:** IT IS POSSIBLE TO CREATE A HISTOGRAM WITH EXCEL TOOLS ONLY—BUT IT CAN BE A TEDIOUS PROCESS.
  - THE RESULTING TABLE OF COUNTS IS USUALLY CALLED A **FREQUENCY TABLE**.
  - THE COUNTS ARE CALLED **FREQUENCIES**.
- IT IS EASIER TO CREATE A HISTOGRAM WITH SOME ADD-INS BUT MANY OF THESE ARE AT A COST.

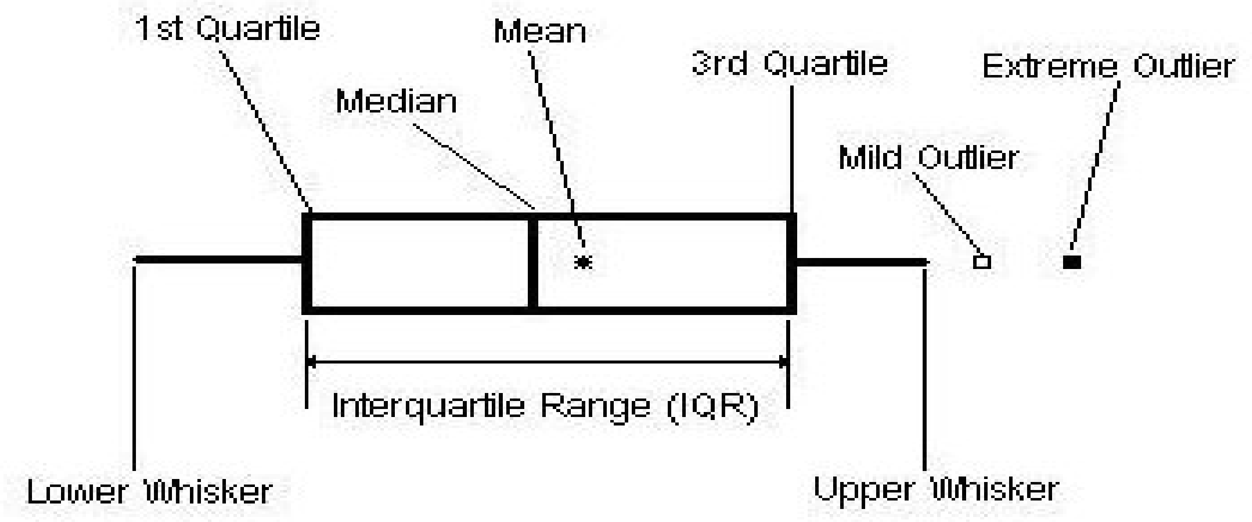
BASEBALL SALARIES 2011.XLSX

Bin	Frequency
414000	57
1503172	417
2592345	70
3681517	60
4770690	41
5859862	43
6949034	25
8038207	29
9127379	11
10216552	13
11305724	9
12394897	14
13484069	9
14573241	12
15662414	8
16751586	6
17840759	1
18929931	5
20019103	6
21108276	1
22197448	1
23286621	2
24375793	1
25464966	0
26554138	1
27643310	0
28732483	0
29821655	0
30910828	0
More	1



BOX PLOTS

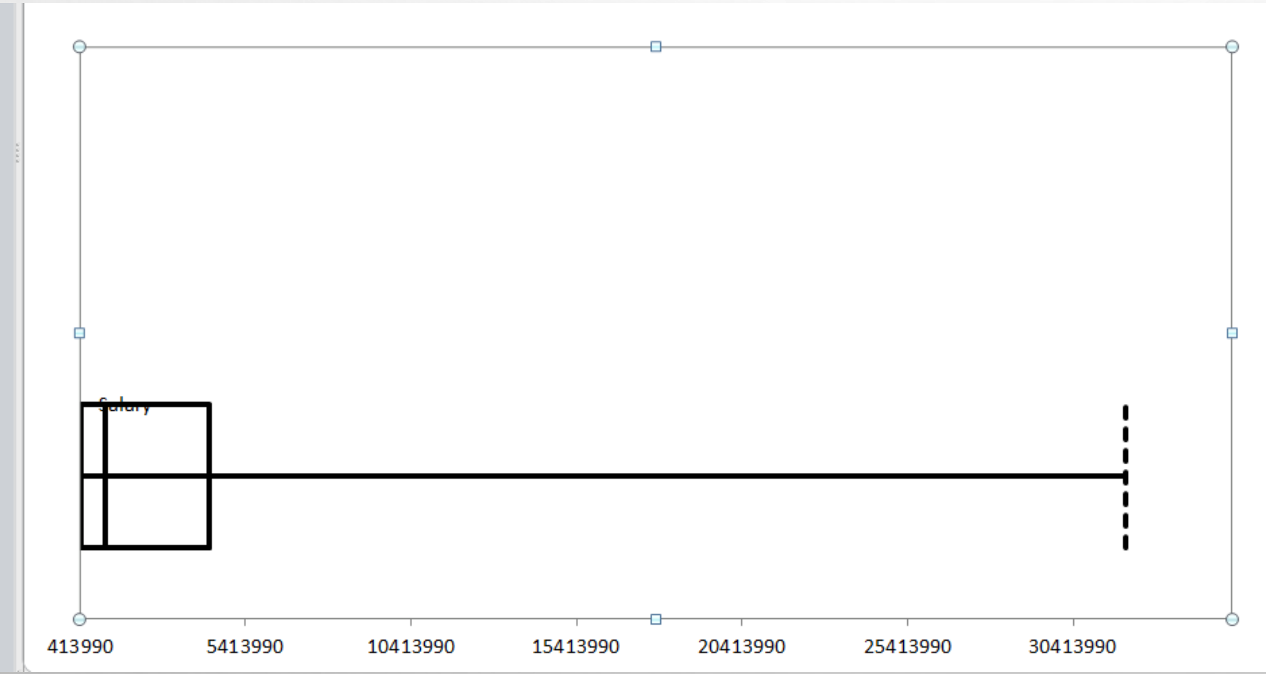
- A **BOX PLOT** (OR **BOX-WHISKER PLOT**) IS AN ALTERNATIVE TYPE OF CHART FOR SHOWING THE DISTRIBUTION OF A VARIABLE.
  - THE ELEMENTS OF A GENERIC BOX PLOT ARE SHOWN BELOW:



Whiskers extend to the furthest observations that are no more than 1.5 IQR from the edges of the box. Mild outliers are observations between 1.5 IQR and 3 IQR from the edges of the box. Extreme outliers are greater than 3 IQR from the edges of the box.

BASEBALL SALARIES 2011.XLSX

- **OBJECTIVE:** TO ILLUSTRATE THE FEATURES OF A BOX PLOT, PARTICULARLY HOW IT INDICATES SKEWNESS.
- **SOLUTION:** IN PHSTAT, SELECT BOX-PLOT FROM THE DESCRIPTIVE STATISTICS DROPDOWN LIST AND FILL IN THE DIALOG BOX.



TIME SERIES DATA

- OUR MAIN INTEREST IN TIME SERIES VARIABLES IS HOW THEY CHANGE OVER TIME, AND THIS INFORMATION IS LOST IN TRADITIONAL SUMMARY MEASURES AND IN HISTOGRAMS OR BOX PLOTS.
- FOR TIME SERIES DATA, A **TIME SERIES GRAPH** IS USED. THIS IS A GRAPH OF THE VALUES OF ONE OR MORE TIME SERIES, USING TIME ON THE HORIZONTAL AXIS.
  - THIS IS ALWAYS THE PLACE TO START A TIME SERIES ANALYSIS.

CRIME IN US.XLSX

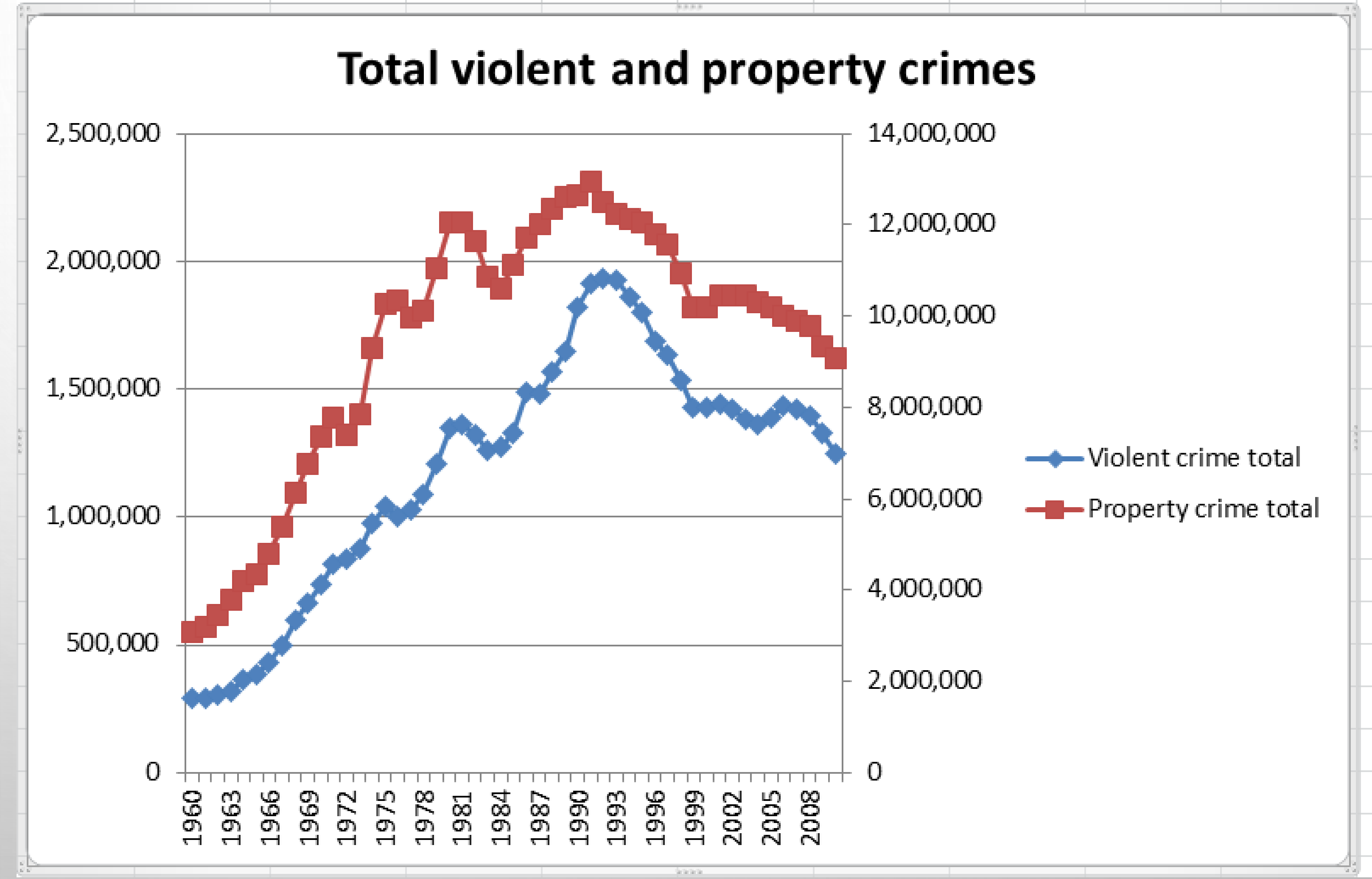
- **OBJECTIVE:** TO SEE HOW TIME SERIES GRAPHS HELP TO DETECT TRENDS IN CRIME DATA.
- **SOLUTION:** DATA SET CONTAINS ANNUAL DATA ON VIOLENT AND PROPERTY CRIMES FOR THE YEARS 1960 TO 2010.

	A	B	C	D	E	F	G	H	I	J	K
1	Year	Population	Violent crime total	Murder and nonnegligent manslaughter	Forcible rape	Robbery	Aggravated assault	Property crime total	Burglary	Larceny-theft	Motor vehicle theft
2	1960	179,323,175	288,460	9,110	17,190	107,840	154,320	3,095,700	912,100	1,855,400	328,200
3	1961	182,992,000	289,390	8,740	17,220	106,670	156,760	3,198,600	949,600	1,913,000	336,000
4	1962	185,771,000	301,510	8,530	17,550	110,860	164,570	3,450,700	994,300	2,089,600	366,800
5	1963	188,483,000	316,970	8,640	17,650	116,470	174,210	3,792,500	1,086,400	2,297,800	408,300
6	1964	191,141,000	364,220	9,360	21,420	130,390	203,050	4,200,400	1,213,200	2,514,400	472,800
7	1965	193,526,000	387,390	9,960	23,410	138,690	215,330	4,352,000	1,282,500	2,572,600	496,900
8	1966	195,576,000	430,180	11,040	25,820	157,990	235,330	4,793,300	1,410,100	2,822,000	561,200
9	1967	197,457,000	499,930	12,240	27,620	202,910	257,160	5,403,500	1,632,100	3,111,600	659,800
10	1968	199,399,000	595,010	13,800	31,670	262,840	286,700	6,125,200	1,858,900	3,482,700	783,600

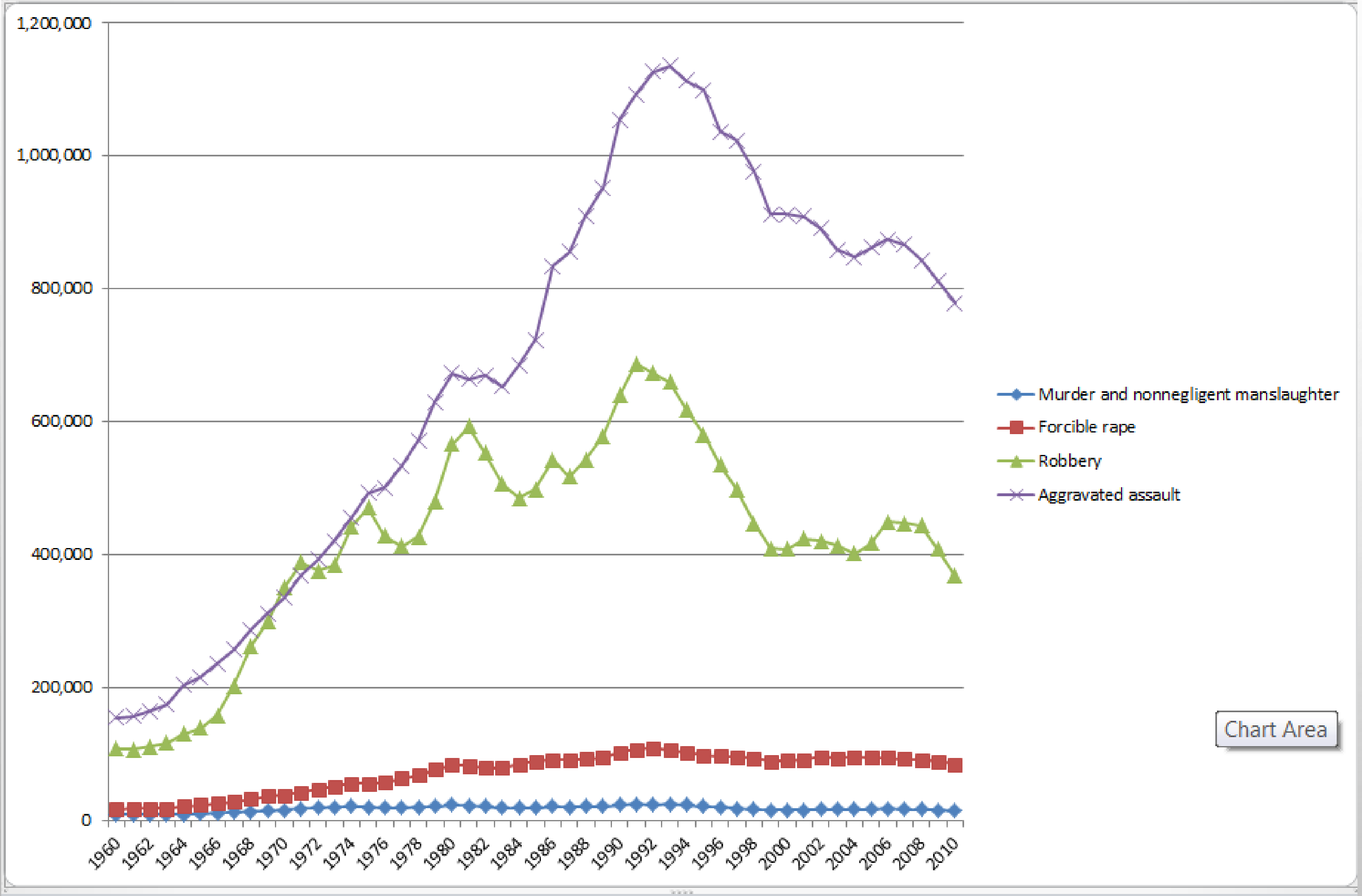
CRIME IN US.XLSX

TOTAL VIOLENT AND

PROPERTY CRIMES



CRIME IN US.XLSX



SPARKLINE GRAPH

- NEW TO EXCEL 2010 IS THE MINI-CHART EMBEDDED IN A CELL. IT IS ESPECIALLY USEFUL FOR TIME SERIES DATA.
- IN THE CELL UNDER A SET OF TIME SERIES DATA INCLUDE A SPARKLINE

6.8976	6.5645	44.9143	81.6470	11.9963	0.7133
6.7209	6.5267	44.3010	83.1771	11.7059	0.6916
6.8556	6.4957	44.9024	81.1257	11.6542	0.6976
6.7859	6.4746	44.8109	80.4259	11.8055	0.6943
6.7871	6.4575	44.3960	79.2425	11.6741	0.7005
7.0871	6.4036	45.3135	76.9657	12.2366	0.6977
7.5769	6.3885	47.6905	76.7957	13.0637	0.7274
7.9540	6.3710	49.2020	76.6430	13.4379	0.7282
8.1493	6.3564	50.6785	77.5595	13.6955	0.7376
8.1933	6.3482	52.3824	77.7967	13.7746	0.7602

DJIA MONTHLY CLOSE.XLSX

- **OBJECTIVE:** TO FIND USEFUL WAYS TO SUMMARIZE THE MONTHLY DOW DATA.
- **SOLUTION:** DATA SET CONTAINS MONTHLY VALUES OF THE DOW FROM 1950 THROUGH 2011.
- CREATE SUMMARY MEASURES AND TIME SERIES GRAPHS FOR MONTHLY VALUES AND PERCENTAGE CHANGES OF THE DOW.

One Variable Summary	Closing Value DJIA Data
Mean	3484.13
Std. Dev.	4044.57
Median	969.26
1st Quartile	764.58
3rd Quartile	5616.21

One Variable Summary	Percentage Change DJIA Data
Mean	0.00642
Std. Dev.	0.04182
Median	0.00851
1st Quartile	-0.01721
3rd Quartile	0.03289

DJIA MONTHLY CLOSE.XLSX