Spatial Measures of Central Tendency:

Spatial statistics can be defined as a statistical description of spatial data and a spatial pattern or process.

Spatial statistics allows the exploration and modeling of spatial patterns and processes and their relationships with other spatial phenomena. Spatial statistics differ from traditional statistics in that spatial statistics integrate space and spatial relationships in the analysis. Spatial statistics can be used with continuous data as well as three different types of object data: points, lines, and areas.

Different spatial statistics can be used depending on the type of data available. Lastly, spatial statistics are closely related to a broader term "spatial analysis", which includes spatial data visualization in geographic information.

Spatial Measures of Central Tendency

Mean Center

the mean was discussed as an important measure of central tendency for a set of data. If this concept of central tendency is extended to locational point data in two dimensions (X and Y coordinates), the average location, called the mean center, can be determined.

the only stipulation is that the phenomenon can be displayed graphically as a set of points in a two-dimensional coordinate system.

The directional orientation of the coordinate axes and the location of the origin are both arbitrary.

Once a coordinate system has been established and the coordinates of each point determined, the mean center can be calculated by separately averaging the X and Y coordinates, as follows:

$$\bar{X} = \frac{\sum x_i}{n}$$

$$\bar{Y} = \frac{\sum y_i}{n}$$

Table 1 Non-spatial and Spatial Descriptive

Statistics	Central Tendency	Absolute Dispersion	Relative Dispersion
Nonspatial	Mean	Standard Deviation	Coefficient of Variation
Spatial	Mean Center or Median Center or Euclidean Median	Standard Distance	Relative Distance

where:

$\bar{X}$= mean center of X

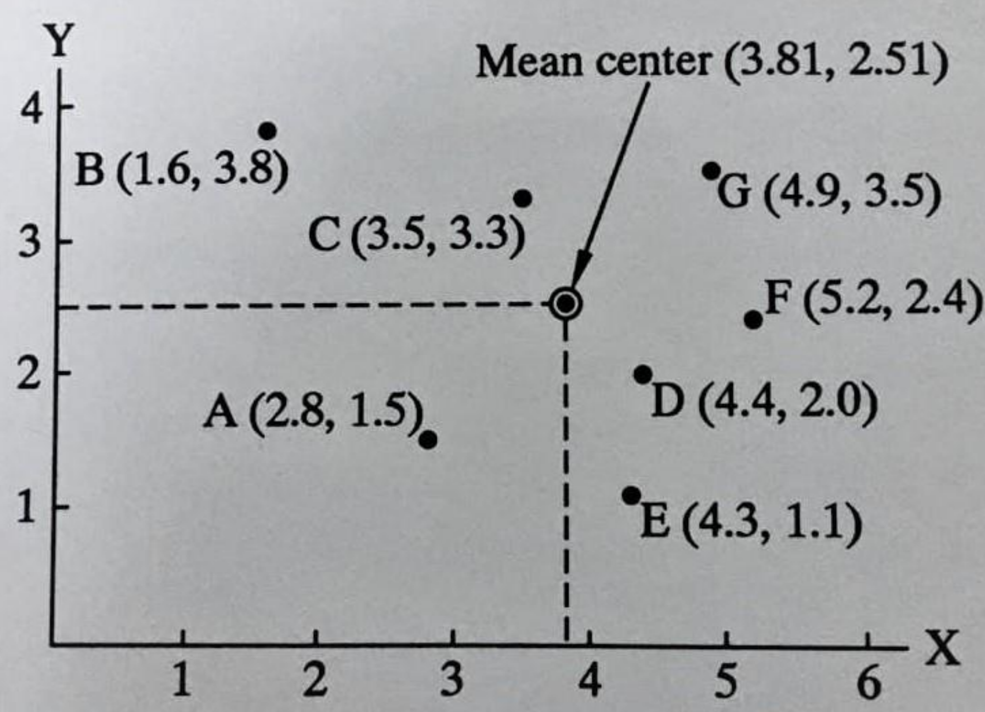
$\bar{Y}$= mean center of Y

Xi = X coordinate of point i

Yi = Y coordinate of point i

n = number of points in the distribution

Figure 4.1 Graph of Locational Coordinates and Mean Center



For the point pattern shown in figure 4.1, the mean center coordinates are $\bar{X}$= 3.81 and $\bar{Y}$ = 2.51 (table 1).

The mean center is strongly affected by points at atypical or extreme coordinate locations.

Suppose, for example, that one additional point with coordinates (15, 13) is included in the previous example. The mean center location would dramatically shift from (3.81, 2.51) to (5.21, 3.82), a relocation to a coordinate position with larger X and Y coordinates than any of the other 7 points. Thus, while the center represents an average location, it may not represent a "typical" location.

Table 1 : Work Table for Calculating Mean Center

Point	X_i	Y_i
A	2.8	1.5
B	1.6	3.8
C	3.5	3.3
D	4.4	2.0
E	4.3	1.1
F	5.2	2.4
G	4.9	3.5
n= 7	$\sum X_i$ = 26.7	$\sum Y_i$ = 17.6

$$\bar{X} = \frac{\sum x_i}{n} = \frac{26.7}{7} = 3.81$$

$$\bar{Y} = \frac{\sum y_i}{n} = \frac{17.6}{7} = 2.51$$

The mean center coordinate = (3.81, 2.51)

The mean center may be considered the center of gravity of a point pattern or spatial distribution. Perhaps the most widely known application of the mean center is the decennial calculation of the geographic "center of the population" by the U.S. Bureau of the Census.

This is the point where a rigid map of the country would balance if equal weights (each representing the location of one person) were situated on it. Over the last 2 centuries, the westward movement of the U.S. population has continued without significant interruption, which is reflected in the concomitant westward shift of the center of the population.

The weighted mean center is defined as follows:

$$\bar{X} = \frac{\sum f_i \, x_i}{n}$$

$$\bar{Y} = \frac{\sum f_i \, y_i}{n}$$

$\bar{X}$= weighted mean center of X
$\bar{Y}$ = weighted mean center of Y
fi = frequency (weight) of point i

Example: find the weighted mean center for the following data:

	xi	yi	Weight
1	100	100	80
2	100	150	170
3	150	150	300
4	150	200	190
5	200	200	450

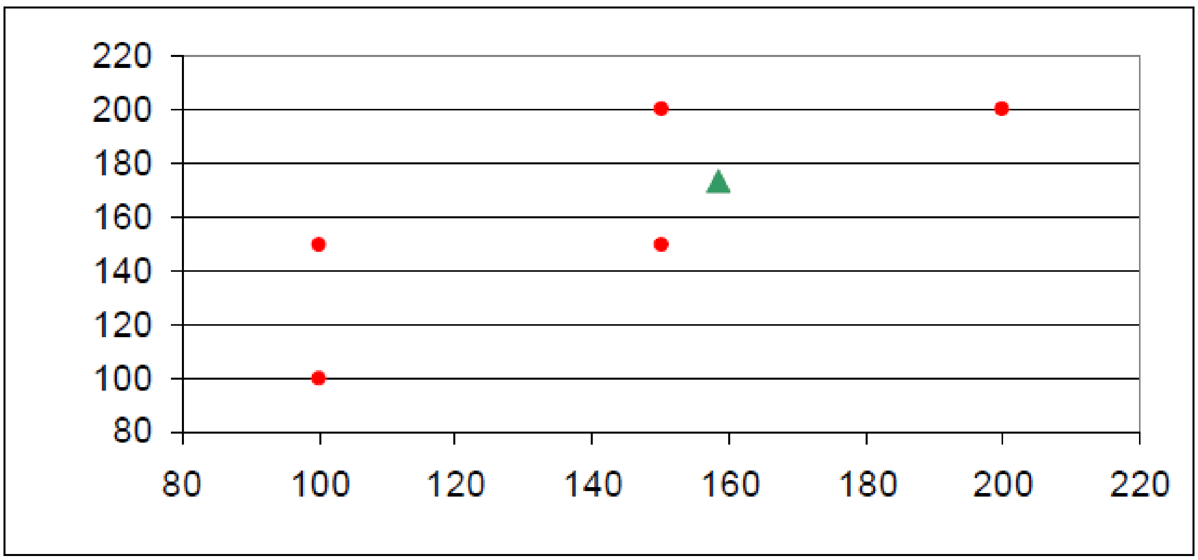
Solution

	xi	Weight	Xi * Weight	yi	yi * Weight
1	100	80	8000	100	8000
2	100	170	17000	150	25500
3	150	300	45000	150	45000
4	150	190	28500	200	38000
5	200	450	90000	200	90000
		1190	188500		206500

$$\bar{X} = \frac{\sum f_i \, x_i}{n} = \frac{188500}{1190} = 158.4$$

$$\bar{Y} = \frac{\sum f_i \, y_i}{n} = \frac{206500}{1190} = 173.5$$

The mean weight coordinate = **(158.4 , 173.5)**



The Median Center

The Median Center is the cartographic equivalent of the center of gravity in geometry.

It's a very simple way to determine where most of the points are clustered, and is applicable to any geographical feature that forms a point distribution (ie, NOT a line or area), such as the distribution of cities, factories, shops, high-rise buildings, etc.

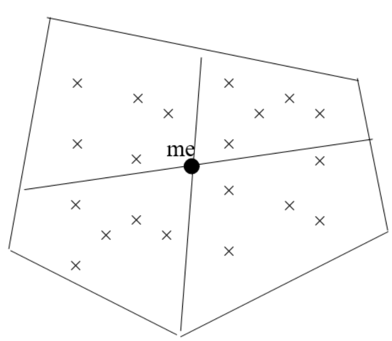
To find the Median Center:

Plot the points on a map

Draw a line North-South leaving an equal number of points on each side (left/right)

Draw a line East-West leaving an equal number of points on each side (top/bottom)

The intersection of both lines is the Median Center.



It can be used to find a suitable location for something that needs to be centrally located. The Median Center will gravitate towards an area with the most features.

The Median Center is good for finding the most accessible location.

Example

The following points represent weather stations centers.

find the spatial mediator for them.

weather stations centers	X	Y
1	10	4
2	16	8
3	8	9
4	24	12
5	18	16
6	28	13
7	11	10
8	30	20

The solution

First: calculate the median of the Y-coordinate as follows:

a) We arrange the coordinates in ascending or descending order.

4, 8, 9, 10, 12, 13, 16, 20

Median1 = $\frac{n}{2} = \frac{8}{2} = 4^{th}$

Median2 = $\frac{n}{2} + 1 = \frac{8}{2} + 1 = 5^{th}$

Median = Median1 + Median2

$$= \frac{10+12}{2} = 11$$

Second: calculate the median of the X-coordinate as follows:

We arrange the coordinates in ascending or descending order.

8,10,11,16,18,24,28,30

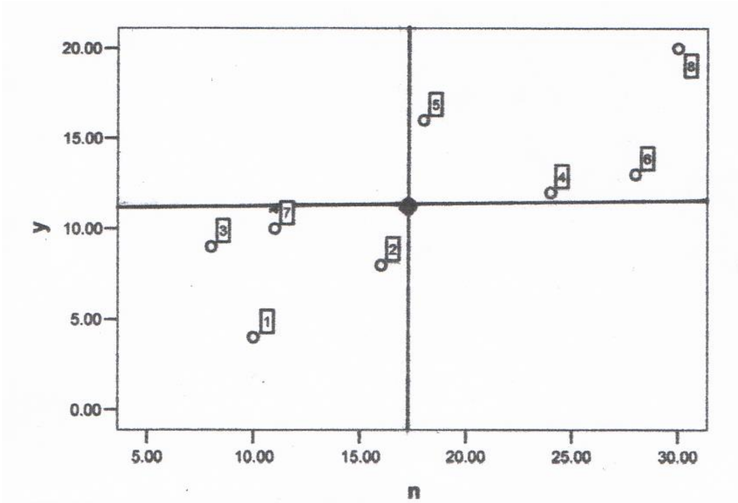
Median1 = $\frac{n}{2} = \frac{8}{2} = 4^{th}$

Median2 = $\frac{n}{2} + 1 = \frac{8}{2} + 1 = 5^{th}$

Median = Median1 + Median2

$$= \frac{16+18}{2} = 17$$

Therefore, the median position (spatial median) (x , y) of the weather stations centers is (17 , 11) After that, the median position “spatial median” can be determined by the point of intersection of the vertical and horizontal events, as shown in the following figure:



The figure shows that the spatial median is in the middle of the weather stations centers, so that half of them fell at the top of the horizontal axis and the other half fell at the bottom, in addition to that half of them fell to the east of the vertical axis and the other half fell to its west.