A **semivariogram** is a fundamental tool used in spatial statistics and geostatistics to measure the spatial dependence or correlation between values at different locations in a field or dataset. It's commonly used in the context of spatial interpolation, such as Kriging.

How it works:

1. Spatial Dependency

The semivariogram describes how the variance (or "spread") between data points changes as a function of the distance between those points. In simpler terms, it shows how similar (or dissimilar) measurements at different locations are, depending on how far apart they are.

2. Calculation of Semivariance

For two points, the semivariance $\gamma(h)$ at a given lag distance h is calculated as:

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} [Z(x_i) - Z(x_i + h)]^2$$

Where:

- $\gamma(h)$ is the semivariance at distance h,
- $Z(x_i)$ is the value of the variable at location x_i,
- $N(h)$ is the number of pairs of data points separated by distance h.

In short, it compares the squared differences of values at pairs of points separated by distance h.

3. The Semivariogram Plot

The semivariogram is usually plotted as a graph of **semivariance** ($\gamma(h)$) on the y-axis vs. **distance** (lag, h) on the x-axis. The graph typically shows:

- **Nugget**: The semivariance at a very small distance, often reflecting measurement errors or spatial variability at very small scales (where data is almost identical for very close points).
- **Sill**: The maximum semivariance, representing the point at which the spatial correlation becomes negligible, i.e., beyond this distance, the points are essentially uncorrelated.
- **Range**: The distance at which the semivariogram reaches the sill. Beyond this range, the spatial dependence diminishes.

4. Interpretation

- **Small Semivariance** (at short distances): This indicates that data values at those points are similar (high correlation).
- **Increasing Semivariance**: As distance increases, if the semivariance increases, it suggests that the data values are becoming more dissimilar.
- **Plateauing Semivariance**: If it reaches a plateau (the sill), this means that at larger distances, there is no longer any spatial correlation between the points.

5. Application

The semivariogram is used in spatial modeling and geostatistical methods like **Kriging** to predict values at unknown locations based on observed data.