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SPATIAL INTERPOLATION IN DIGITAL MAPS

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Abstract:

Geographers use different methods to study and analyze geographical data for natural and human phenomena. One of these methods is spatial completion, which is a prediction of missing values located between a limited number of sample points for graphic information and can be used to predict unknown values for any geographical data. The hypothesis that makes spatial completion a feasible option is that spatially distributed phenomena are also related to each other spatially. In addition, interpolation is one of the important options in spatial analyzes of GIS software. This software helps to obtain high-accuracy results and clarity of data for various natural and human phenomena.

Introduction:

The map is the means that the geographers adopt in completing their studies in the natural and human aspects. Given that the map is the microcosm of the earth obtained from the use of geographic information systems (GIS). It helps to create an effective digital geographic database to store large quantities of statistical data that facilitate the visibility of spatial relationships of phenomena in a moving manner on the maps provided by geographic information systems. There are representation and perception of geographical data employed by GIS in the preparation and representation of models. In addition, modeling geographical phenomena facilitates the process of dealing with private and public data within the effective geographical database for the flexibility it provides in conducting the processes of updating, deleting and continuous addition. GIS contributes to the understanding and awareness of the information contained in the geographical maps and facilitates the process of analyzing and

showing the changes for each method to prepare high-accuracy maps and prediction of the values of geographical data. These data are the last of the spatial analyzes of the GIS software.

Cartographic modeling with spatial interpolation methods:

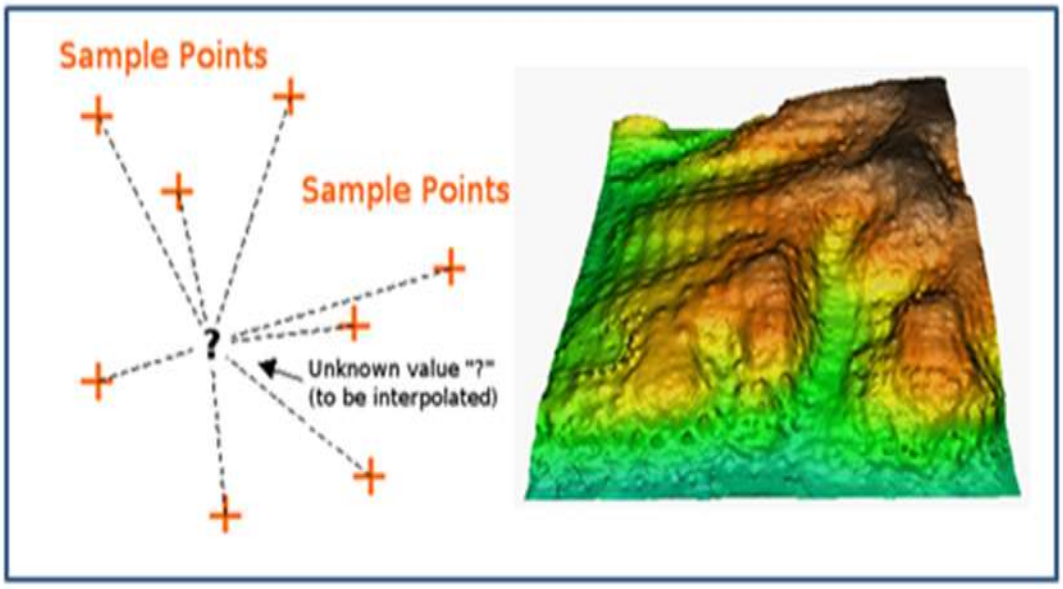
Spatial Completion Maps spatial Interpolation is the uniqueBoukasi of the representation of surfaces. The scientific style in these models depends on taking the data available in certain places of the study area, and then predict the required data in areas where there are no measurements (Al-Azzawi, 2019). It provides spatial analysis within spatial interpolation of various modalities of the completion process that in turn create a continuous cellular surface Cell surface of features from attributes points- natural and human phenomena (Omar Abdullah Al-Qassab, 2020).

In general, spatial interpolation methods can be divided into two groups, which are mathematical derivation and statistical derivation. These two methods are used in modeling spatial data such as (Daoud, 2018):

1. The inverse weighted distance method Inverse distance weighting
2. The creaking method Kriging
3. Natural neighbor method Natural neighbor
4. Slide method Spline with Tension
5. Surface-to-retina method Topo to raster
6. Direction method Trend

All of these methods require that the data be in raster form (point as in Figure (1).

Figure 1 : Illustrates the mechanism of action within the spatial completion

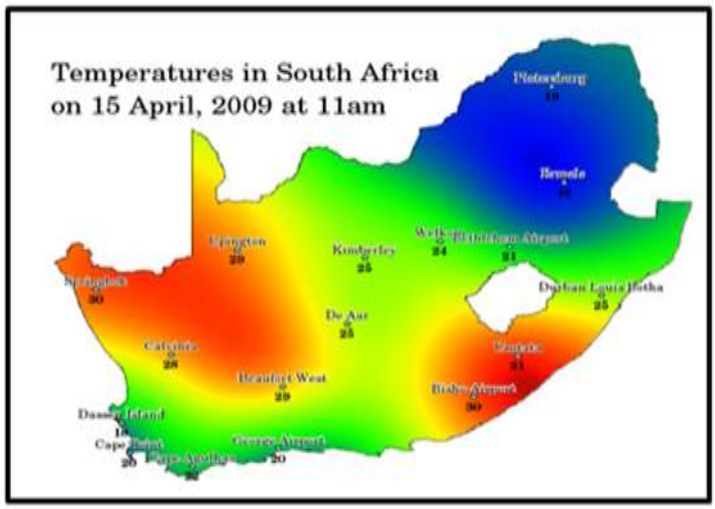


("Interpolation,")

There are those who give a more comprehensive detail of the concept of spatial analysis as a process of using points with known values to estimate values at other unknown points. For example, to create a rainfall map for a specific country, there are no enough weather stations evenly spread to cover the entire region. It can be estimated at the analysis of the spatial temperature in locations without data recorded using temperature readings known in the near weather stations is often called this type of surface to the surface interpolated **Statistician**. Elevation data, heavy rainfall, snow, water level and population density are other types of data that can be calculated using the methods of spatial interpolation (Babu) as Figure (2) shows.

The spatial integration of these points can be applied to create a point surface with estimates made for all the point cells in the GIS Due to the high cost and limited resources. The data is usually collected in a limited number of specified locations. To create a continuous map, for example, a digital elevation map from elevation points measured with a device of GPS must be use the method of perfection appropriate to estimate values as optimal in those locations where no sampling or measurements were taken. The results of the completeness analysis can then be used for analyzes that cover the entire region (Diggle, 2007).

Figure 2: The temperature map is distorted from the weather stations in South Africa



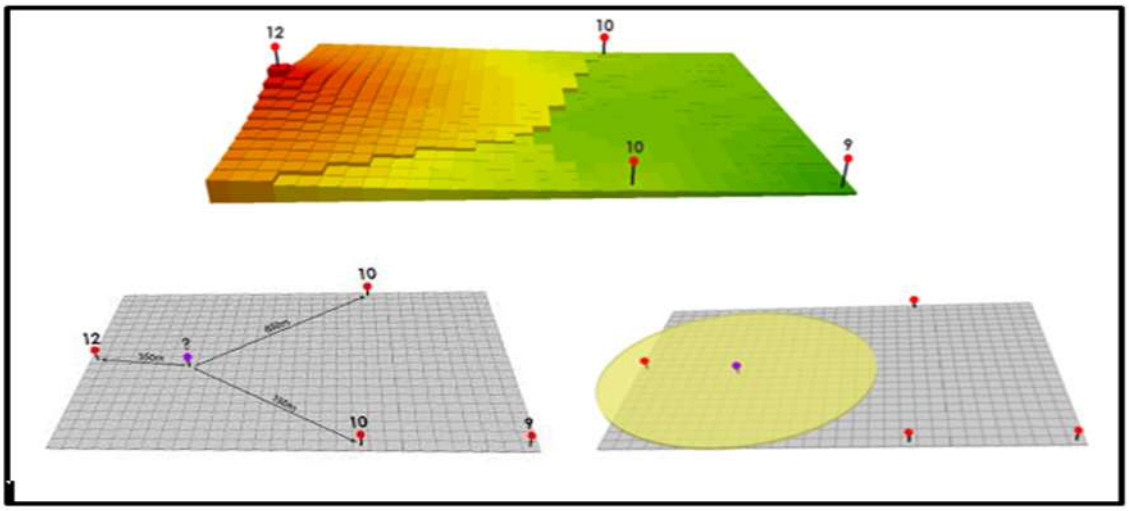
This figure is adopted from P. Longley (1999)

Inverse gravitational distances method (IDW)

The method of distances is based on inverse weight (IDW) on the adjacent nearby points to find a weight for each site adjacent to the point to be assessed (Al-Karnaz, 2017). In the process of interpolation, it depends on the distances between the locations of the control points. When the group of control points is sufficiently large and close, the identification of the discrepancy between the phenomenon values becomes clearer (Al-Karnaz, 2017). That is, each point has a relationship to another point, and the more the points are close to each other, the closer the relevance of the distant one is (Muhsin, 2013). The updated values for the surfaces of IDW is calculated as a weighted average of the values of a group of proximal points. The disadvantage of this method is that gives continuation in the form of eyes or round

lenses(Omar Abdullah Al-Qassab, 2020). This relationship depends on the power of decimal power of ten. We find that with the increase in Wallace decimal points is less than the effect of these, and this method appeared in 1968 at the hands of the researcher Shepherd. It is a common ways of applying the spatial applied of in the GIS. It could set interpolation so that it takes a fixed or variable number of points where we notice that the red points represent the values of the height and the other points are twisted. To measure the purple point in this figure, it uses a fixed number of points (3) points and uses the closest three points, then in different ways The radius of your research and interpolation are selected and will only use the number of known points within the radius of the area to be studied (A.G., 1986) as in Figure (3) .

Figure 3: Shows the figure generated by applying the inverse weighted distance method (IDW)



("The shape generated by applying the Natural Neighbor," 2020)

The creaking method Kriging:

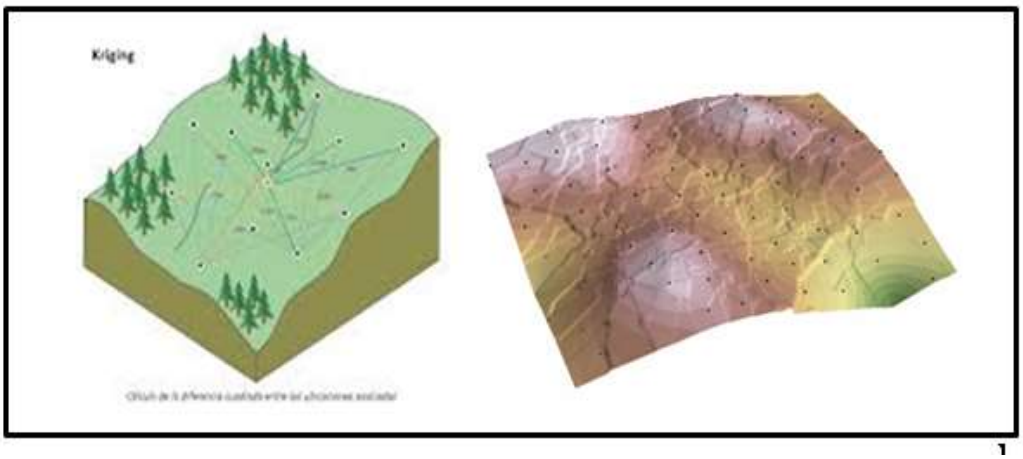
It is one of the methods of analysis within spatial Interpolation. It calculates the measurement of the spatial complementarity between the observed control points to describe the difference in the surface (Al-Mashagloah, 2012). It is very similar to the first method (IDWAs). The method Kriging uses the arithmetic mean in the spatial interpolation process, but in a more complex way (Earls & Dixon, 2005). Kriging is used to determine the statistical properties of the measured field, then apply these characteristics in calculating the field value at the unknown point(s) (Daoud, 2018).

The method is divided into two methods, the normal ordinary Kriging which assumes the existence of a constant reasonable average. However, sometimes there are scientific reasons that reject this assumption, and this the prediction method is considered by simple ordinary Kriging. It enjoys remarkable flexibility. The second method is Universal Kriging which assumes that the mean is not constant and is unknown. So we find that the regular Kriging method is the most colloquial and widely used (Thanoon, 2018) as Figure (4) shows.

The methodology followed by the researcher is to use of Kriging. It depends on the surrounding values measured or on specific mathematical equations that determine

the surface smoothness resulting from the use of this method. It explains the automatic correlation, i.e. the statistical relationships between the measured points. For this reason, geostatistical techniques not only have the ability to produce a prediction surface, but also provide a measure of certainty or accuracy in predictions (Stein, 1999).

Figure 4: Represents the shape generated by the Ordinary Kriging method



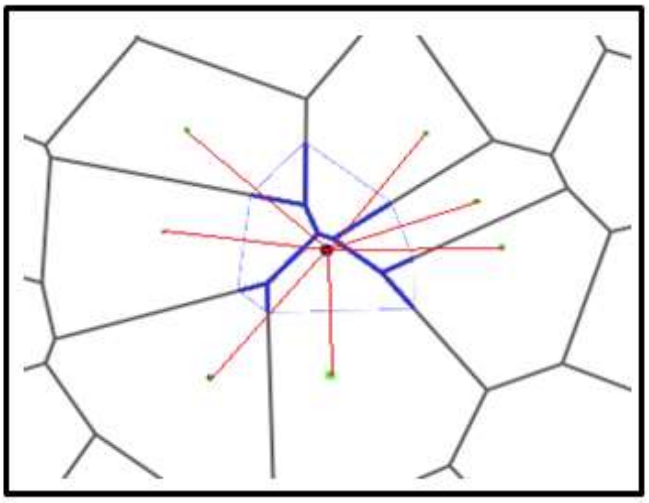
(“Delaunay Triangulation,” 2020)

The distance or direction between sample points in the Kriging method reflects a spatial correlation that can be used to explain the variation in the surface. It is a tool that fits a mathematical function for a certain number of points, or all points within a specified radius to determine the value of the phenomenon for each site. It includes exploratory statistical analysis of data, and modeling Variants and creates a surface, and (optionally) explore contrast surface. Kriging is often best suited when you there is a known spatially correlated distance or directional bias in the data for soil and geology research (N, 1993).

Natural Neighbor:

Spatial interpolation by the natural neighbor method is an effective method for estimating data, however this method is not easy to apply (Musashi&Pramoedyo, 2018). Spatial interpolation within the natural neighbor method has many positive features, and can be used for both interpolation or extrapolation, and works well with scattered points (Liang & Hale, 2010). The natural neighbor method is based on the principle that proximity points have a large impact when calculating the value of the unknown point(G.Garnero&D.Godone, 2013). However, unlike the inverse gravitational distances method (IDW), it tries to locate the closest neighbors Natural Neighbor to take them into account / calculations. The natural neighbor method draws a polygon around each known point, so that the weight (effect) is based on "the area of the polygon and not its proximity or distance to the unknown points(Daoud, 2018)as in Figure (5).

Figure 5: The shape generated by applying the Natural Neighbo

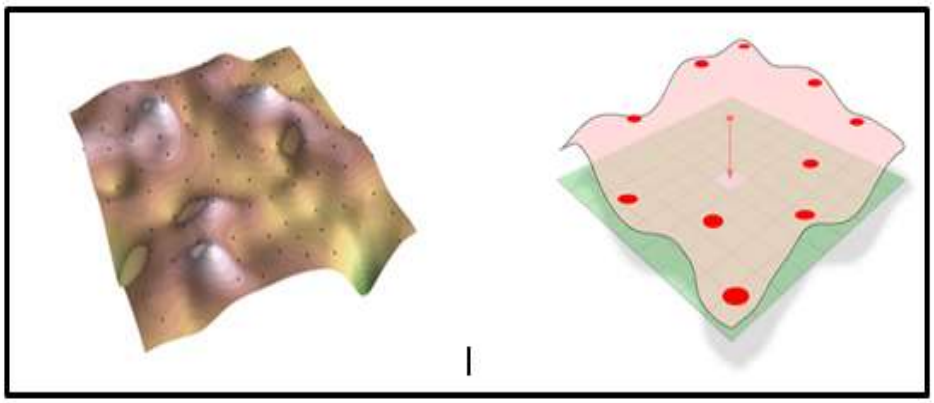


("The shape generated by applying the Natural Neighbor," 2020)

Spline with Tension:

This method is one of the methods for generating induction surfaces and is a mathematical function that reduces the curvature of the surface (Al-Bakei&Hapep, 2020). It depends on the mathematical transformation process and not on the distance to represent the weight element (i.e. the effect of the point with a known value on the target points for which the values are to be obtained inversely proportional "with the distance between them. This is the case with the inverse gravitational distances method)IDW) and the Kriging(Ali, 2015). There are two types of mathematical models of **Spline.** The first is the Flexible or usual type regularized Spline which aims to find a smooth surface even if it has values outside the measured data range and the second **Tension Spline** which controls this surface so that it only passes the measured values (Daoud, 2018) (Figure 6).

Figure 6: Shows the figure generated by applying the slice method

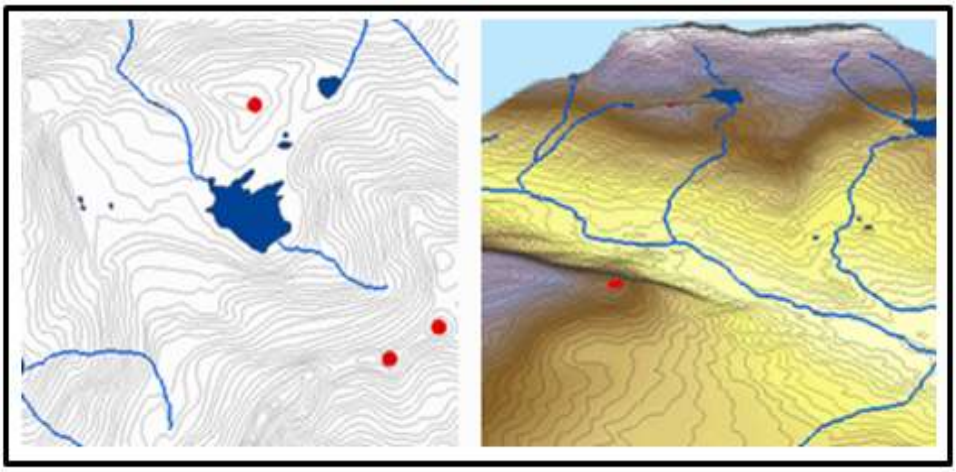


("Types of Interpolation Methods ", 2020)

Surface-to-retina method Topo to raster

This method is primarily designed to deal with contour maps for deriving elevations. It is mainly a hydrological method for deriving elevations from known points, contour lines, surface drainage meshes, or lake polygon (Daoud, 2018).This is done by fulfilling the values of the point height. This method imposes a number of restrictions, one of which is that there should be a hydrological model (Arseni, 2019). The **Topo to raster** method was designed to handle the input contour (D &Trintakonstantis, 2002) (see Figure 7)

Figure 7: Pattern generated by applying the surface-to-retina method

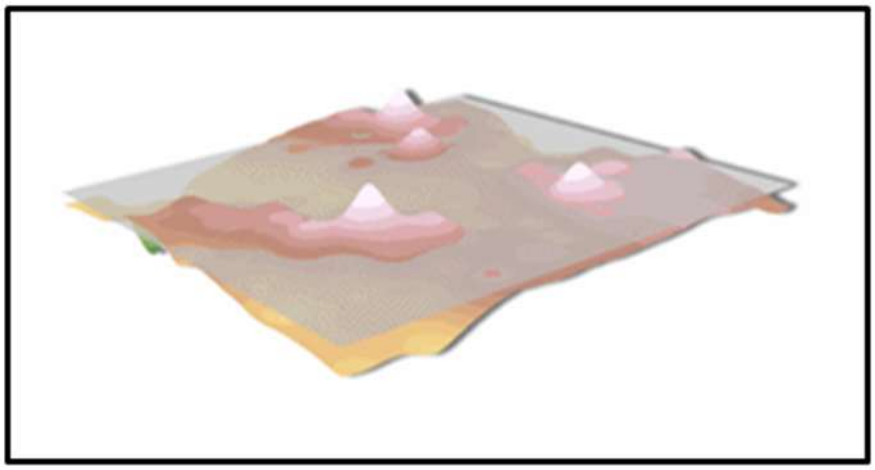


("Types of Interpolation Methods ", 2020)

Trend:

It is a statistical method that works to find the surface that is proportional to a group of sample points by using regressions (Babu) which depends on the convergence of a point surface from similar points. It is the interpolation of the global polynomial by a mathematical function (polynomial) that gradually changes the surface of the direction and captures the converging patterns. In the data, it tries to find more surface (the regression equation) that is identical to the sample values while reducing the distortion to the lowest possible value (Daoud, 2018) as Figure (8) shows.

Figure 8: Shows the resulting figure from applying the trend methodtrend))



("Types of Interpolation Methods ", 2020)

Conclusion:

The use of modern technologies represented by spatial analysis techniques such as Geostatical Analysis g to the spatial completion mechanism Spatial Interpolation plays a big role in producing maps with high accuracy and speed. In addition, it gives a clear picture close to reality, and the cartographic models generated by spatial interpolation methods characterized by high visual perception following the use of visual variables which are important means in communicating information to the map reader and its user. The maps, which are most comprehensible in terms of cartographic envisioning, were according to the spatial interpolation mechanism and its used methods. The most accurate geographical studies is the Kriging method where the error rate is very small. It is followed by the natural neighbor method and Inverce Distance Weighting.

The results of spatial completion depend on the type of available data and also the method that is followed in conducting the application process, as each of the spatial completion methods has a response that differs from one another in response to this data and the construction of its models differs from the real data set.

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