Raster Spatial Analysis – Specific Theory

Spatial resampling

Spatial resampling involves the use of algorithms for changing grid cell resolutions and/or changing cell boundaries.

The resample function in a GIS assigns values to new cells based on the input grid cell values using resampling techniques.

cell in geographically correct grid for which a new value will be calculated

geographically correct grid (output grid)

original grid (input grid)
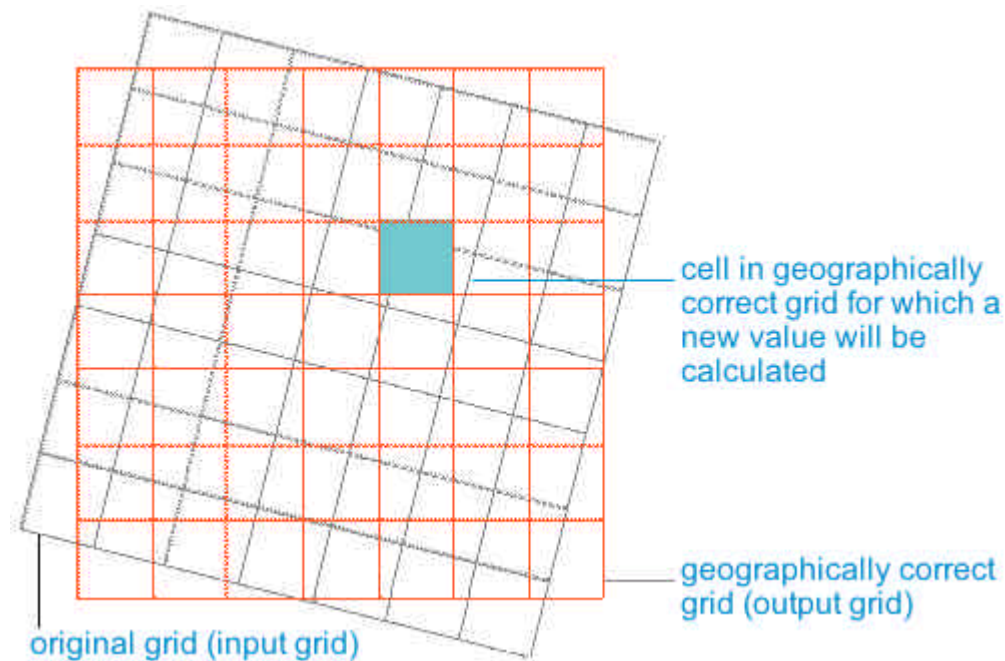
Usually one of the three resampling techniques. These three techniques are:

?? **Nearest neighbour**

?? **Bilinear interpolation**

?? **Cubic**

The **nearest neighbour** method matches the output cell centre to the nearest input cell centre and transfers the input cell value.
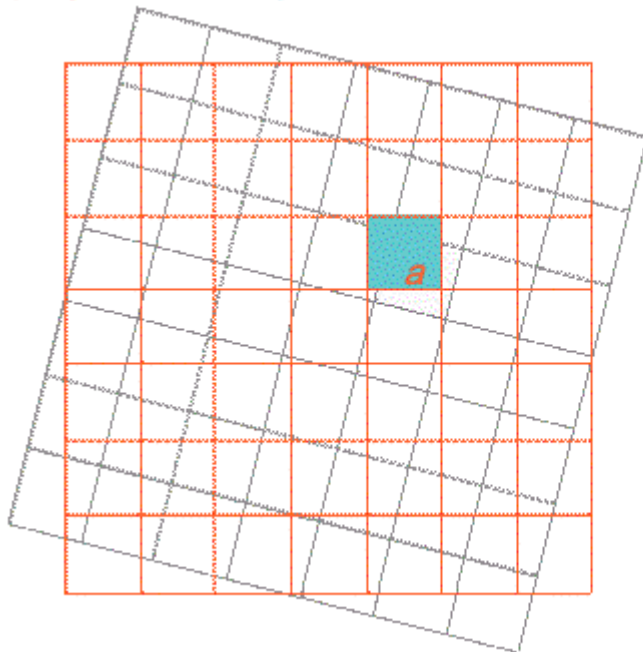
transfer the value of the nearest pixel *a*

This method is appropriate for discrete data, and in some situations for continuous data. It is used primarily for categorical data such as a land use classification, as it will not change the values of the cells. The maximum spatial error will be one half of the cell size.

Bilinear Interpolation determines the output cell value with a weighted distance average of the four nearest input cell centres.
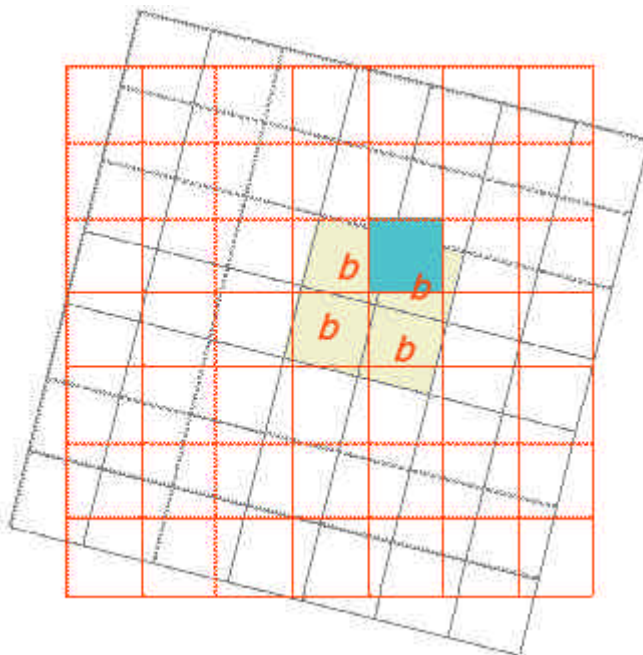
transfer proximity weighted average of the nearest 4 pixels *b*

This method is appropriate for continuous data, but not for discrete data because values are averaged, and hence the cell values may be altered. If the input grid is integer, the output values are truncated to integer. This option will cause some smoothing of the data.

Cubic is similar to bilinear interpolation, except that the nearest 16 cells are used.

transfer evaluated weight of nearest 16 pixels c
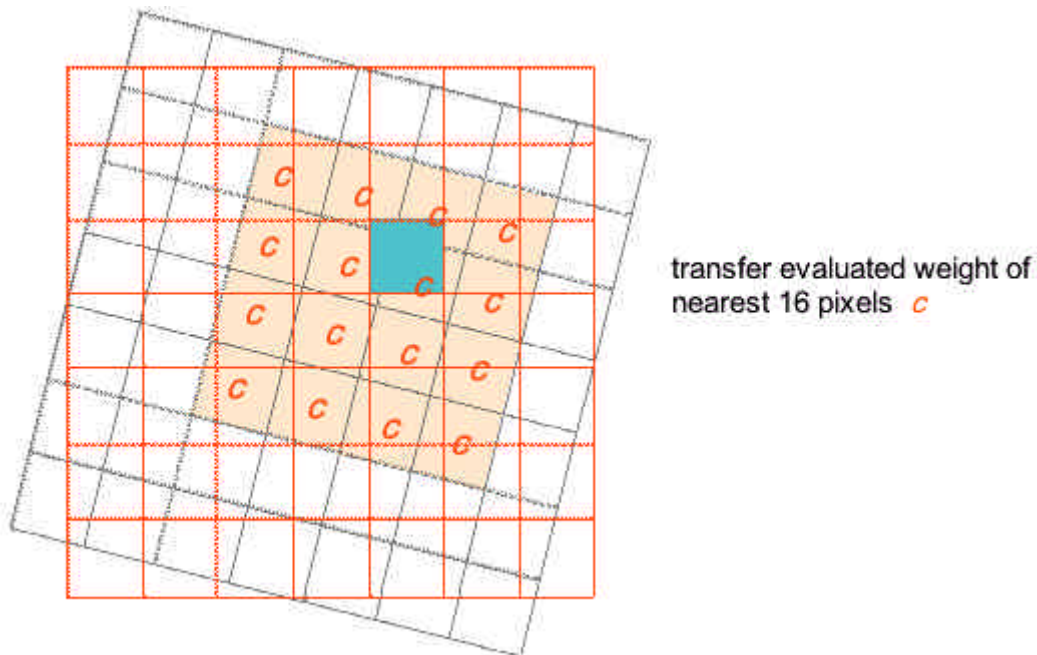
Like bilinear, cubic is appropriate for continuous data, but not for discrete data. This technique will generate a slightly sharper grid than through bilinear interpolation. The grid will be geometrically less distorted than the grid achieved by running the nearest neighbour resampling algorithm.

Mosaic

Mosaicing is a technique commonly used in raster GIS and remote sensing when two or more neighbouring raster layers must be joined into a larger unit.

For example, multiple mapsheets that have been converted to digital elevation models can be combined into a single layer using mosaicing.

Mosaicing fundamentally uses resampling algorithms as new grid cell values are calculated where the maps join or overlap at the edges. Hence mosaicing can be performed using nearest neighbour, bilinear or cubic techniques depending on the scale of measurement of the input data.

Reclassification

Reclassification is a generalisation technique used to re-assign values in an input them to create a new input theme. Reclassification changes the value of the input cells using a remap table on a cell-by-cell basis within the area under analysis.

This technique is commonly used to convert interval and ratio scale data into an ordinal rankings for suitability modelling using map algebra.

Simple classifications are often made so that continuously varying spatial properties such as population density can be displayed in easy-to-understand maps.

Need to Include:

?? Use of remap tables as an input to the reclassification of the data

?? Importance of inclusion of all the lower and upper limits (up to and including etc)

Reclassify in the Analysis menu of ArcView changes the values in a grid theme from one value to another through one of two techniques, reclass (for categorical data) or slice (for continuous data). Reclass changes one value to another in a one-to-one value change. For example, while performing a deer-habitat analysis, the values on a land use grid theme, each representing a different type of land use (categorical data), need to be changed to a preference range of 1 to 10. The types of land most preferred by deer are reclassed to higher values and those less preferred to lower values. For instance, the forest land use is reclassed to 10, the low-density residential land use to 5, and the industrial to 1.

Slice considers all values and their distribution in a grid theme simultaneously, and reclassifies the values into a specific number of groups. In the hypothetical analysis of deer habitat, the second theme to the suitability model is based on the preference of deer for locations far from roads. A distance map (continuous data) is created from the existing roads theme. Instead of individually reclassifying each of the thousands of distance values on a 1-to-10 deer preference scale, the values can be sliced into 10 groups. The farthest group receives the highest deer preference value, a value of 10, and the nearest group, a value of 1.

A variation of the reclass reclassification changes cells to and from No Data. In a suitability analysis for siting a housing development, No Data cells are changed to zero so that the cells are included in the model and yet contribute nothing to the cost in the analysis. But cells that fall within the legal buffer of a wetland, which should not be considered under any condition, are set to No Data so that they will not be available as possible building sites.

Slicing

Slicing is a global function similar to reclassification, however it uses statistical measures to subdivide the region from interval/ratio scales to ordinal rankings.

There are two different approaches to slicing: **equal interval** and **equal area**.

Equal area means that the input values will be divided into *n* zones with each zone having a similar number of cells, i.e. so that each zone represents a similar amount of area.

The **equal interval** slice determines the range of the input values and then divides the range into *n* zones. This means that each zone on the sliced output grid has the potential of having input cell values that have the same range from the extremes; i.e. the values of the input grid are reclassified to alternate values by dividing the input range of values into intervals of equal input data value ranges.

Slicing is useful to simplify displays or analysis of continuous data such as elevation and rainfall. It is also used to reduce the number of categories in an interval level map.

Slice changes a range of values of the input cells by specified ranges, zones of equal area, or zones with equal intervals within the analysis window

Zonal Operations

Zonal operations are also sometimes called region operations or region functions. We commonly use zonal operations as a potential problem exists when we wish to analyse raster data that is not actually the shape of an individual grid cell. For example, neighbourhood operations define their area of interest as a function of individual grid cells. With zonal operations we can analyse spatial definitions of regions by clustering similar or like cell values into homogenous regions.

Zones can be defined at the data capture stage such as when vegetation polygons are digitised. Alternatively, zones can be created using reclassification techniques discussed elsewhere in this module. Processing of zones is formed on a zone-by-zone basis rather than on a cell-by-cell basis neighbourhood.

Each zone of a map layer is a set of contiguous locations that exhibit the same value, which might be:

?? land ownership parcels

?? political units such as counties or nations

?? lakes or islands

?? individual patches of the same

?? soil or vegetation type

A zone such as a vegetation polygon is used in a raster analysis as the definition of the area of interest. Therefore in zonal operations we work with two raster data layers; one defining the zone and the other that we are analysing as a function of the zones. An example of this is where we wish to calculate the average elevation for a particular forest type.

Note that not all map layers will have zones, cell contents may vary continuously over the region making every cell's value unique e.g. satellite sensors record a separate value for reflection from each cell.

References

Berry, J.K. (1995) *Beyond Mapping: Concepts, Algorithms and Issues in GIS*. GIS World Books, Fort Collins, USA..

Burrough, P.A. (1986) *Principles of Geographic Information Systems for Land Resource Assessment*. Monographs on Soil and Resources Survey No. 12, Oxford Science Publications, New York.

Curran, P. J. (1998) *Principles of Remote Sensing*, Longman Scientific and Technical, Essex.

Environmental Systems Research Institute (ESRI) (1996) *Working with the ArcView Spatial Analyst*.

Tomlin, C.D. (1990) *Geographic Information Systems and Cartographic Modelling*. Prentice Hall, New Jersey.